CARAVAN® HOT WATER/OIL INCLUDING DUAL FUEL

APPLICATION GUIDE

WET-BASE CAST-IRON MODULAR BOILERS

Guidelines for the design, purchase and installation of Slant/Fin oil-fired and dual fuel hot water modular boiler systems.

CONTENTS

*All wiring diagrams are based on continuous circulation.

CODES AND STANDARDS

Oil-fired Caravan installations must comply to local codes or, in the absence of local codes, to the ANSI/NFPA 31, Installation of Oil Burning Equipment, latest edition.

In addition, where required by the authority having jurisdiction, the installation must conform to American Society of Mechanical Engineers Safety Codes for controls and safety devices for automatically fired boilers, No. CSD-1. The installation must also conform to the additional requirements of Slant/Fin Instruction Book publication no. L-40 latest edition.

All electrical wiring is to be done in accordance with the National Electrical Code ANSI/NFPA No. 70-latest edition and all local electrical codes. The unit must be electrically grounded if an external power source is used.

In Canada, the installation must be in accordance with standards CGA B149.1 and B149.2, installation codes for oil burning appliances and equipment and/or local codes. All electrical connections are to be made in accordance with Standard C.S.A. C22.1 Canadian Electrical Code Part 1 and/or local codes.

INTRODUCTION OF FRESH WATER

Introduction of excessive amounts of fresh water into a system can cause scaling and leave deposits in the boiler and the surrounding pipes. This will lead to inefficient boiler operation and breakdown. Fresh water will enter the system as a result of hidden leaks such as may occur in underground piping. Relief valves should be piped to a location that shows visible signs of relief.

Process applications that use fresh water, require the use of heat exchangers. Any process application that results in introduction of fresh water into a boiler can cause scaling with deposits forming in the boiler and surrounding piping. This will damage the boiler. Introduction of fresh water from leaks will cause similar damage. Use of fresh water will void warranty.

In some areas it may be necessary to use a feed water treatment to control the corrosive makeup of the feed water. Check with the local authority, to determine if the feed water will need a conditioning treatment before being supplied to the boiler.

INTRODUCTION

This Caravan application manual is intended to simplify the selection and application of Slant/Fin modular systems for a variety of space heating and domestic hot water requirements. Where any additional information is required, contract your local wholesaler, Slant/Fin sales representative, or the Slant/Fin factory.

A. Design flexibility - Caravan modular boiler systems are available in virtually any size capacity simply by adding modules.

B. Boiler room design, size and flexibility - since Caravan modules have the burner and controls mounted to the front, they can be installed with minimum clearances as per codes, thus saving a significant amount of floor space.

C. Faster, easier installation - modules are completely factory assembled, including individual jackets to save on-site labor. Optional easy to install supply and return headers with flexible quick connect fittings are available for hot water systems.

D. Safety - each module contains an individual high limit control and a flame safeguard control. ASME relief valve is provided separately for mounting directly on boiler.

E. Fast domestic hot water recovery - Caravan offers an external heat exchanger of the positive circulating type.

Slant/Fin®

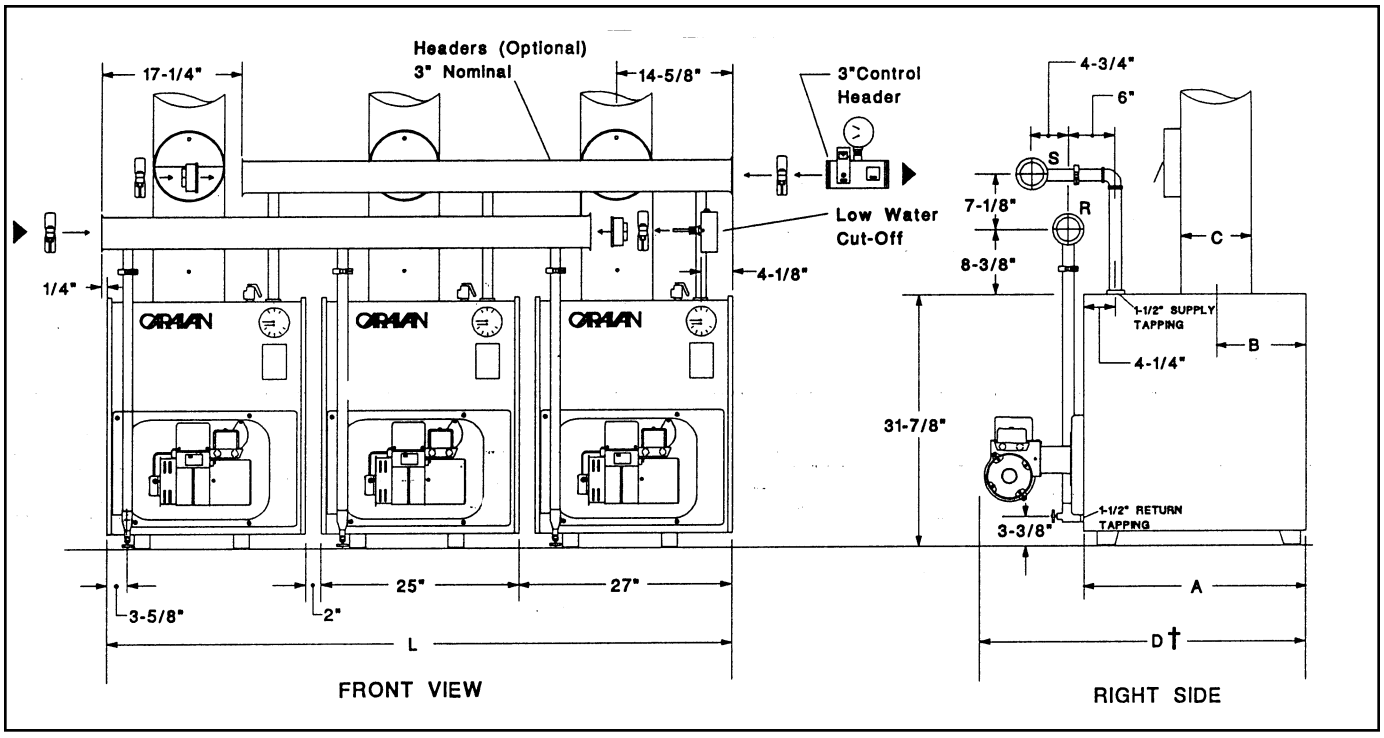
Publication No. CG-10-HWO
Printed in the U.S.A. 1200

Table 1. Oil Caravan ratings hot water models — LDWO Series (75 psi maximum working pressure)

Model No.	No. of Htg. Mod.	Firing Rate #2 Oil GPH*	Ratings (MBH) Input	Ratings (MBH) Gross Output	‡ EDR Water (Sq. Ft.)	I=B=R Net Ratings (MBH)†	Boiler Horse-power	Water Content (gal.)	Ship Wt.	Recom-mended Header Size§
LDWO-600-2-5	2	4.30	602	500	2900	435	14.9	31.0	1570	2"
LDWO-750-2-6	2	5.20	728	596	3453	518	17.8	35.6	1790	2"
LDWO-850-2-7	2	6.00	840	684	3967	595	20.4	45.2	2000	3"
LDWO-900-3-5	3	6.40	896	750	4347	652	22.4	46.5	2355	3"
LDWO-1100-3-6	3	7.80	1092	894	5180	777	26.7	53.4	2685	3"
LDWO-1300-3-7	3	9.00	1260	1026	5947	892	30.6	67.8	3000	3"
LDWO-1700-4-7	4	12.00	1680	1368	7933	1190	40.9	90.4	4000	3"
LDWO-2100-5-7	5	15.00	2100	1710	9913	1487	51.1	113.0	5000	3"
LDWO-2500-6-7	6	18.00	2520	2052	11893	1784	61.3	135.6	6000	3"
LDWO-2900-7-7	7	21.00	2940	2394	13880	2082	71.5	158.2	7000	4"
LDWO-3400-8-7	8	24.00	3360	2736	15860	2379	81.7	180.8	8000	4"

* Light oil, 140,000 Btuh per gallon.
† Net ratings are based on a piping and pick-up allowance of 1.15. Slant/Fin should be consulted before selecting a boiler for installation having unusual piping and pick-up requirements.
‡ Based on 150 Btuh per square foot E.D.R. at 170°F average water temperature.
§ Modules in excess of 8 are piped in parallel to first eight.

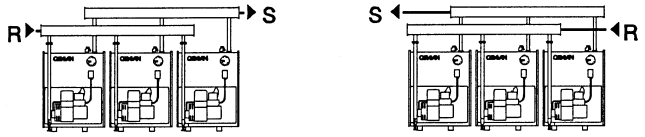
For larger sizes, use multiples of the above.



Model No. ‡	A	B	C	D †	L *
LDWO-600-2-5	21⅝	8⅞₂	8	34⅜	4'4"
LDWO-750-2-6	25	9²⁹⁄₃₂	8	37¾	4'4"
LDWO-850-2-7	28⅜	11¹⁹⁄₃₂	9	41⅛	4'4"
LDWO-900-3-5	21⅝	8⅞₂	8	34⅜	6'7"
LDWO-1100-3-6	25	9²⁹⁄₃₂	8	37¾	6'7"
LDWO-1300-3-7	28⅜	11¹⁹⁄₃₂	9	41⅛	6'7"
LDWO-1700-4-7	28⅜	11¹⁹⁄₃₂	9	41⅛	8'10"
LDWO-2100-5-7	28⅜	11¹⁹⁄₃₂	9	41⅛	11'1"
LDWO-2500-6-7	28⅜	11¹⁹⁄₃₂	9	41⅛	13'4"
LDWO-2900-7-7	28⅜	11¹⁹⁄₃₂	9	41⅛	15'7"
LDWO-3400-8-7	28⅜	11¹⁹⁄₃₂	9	41⅛	17'10"

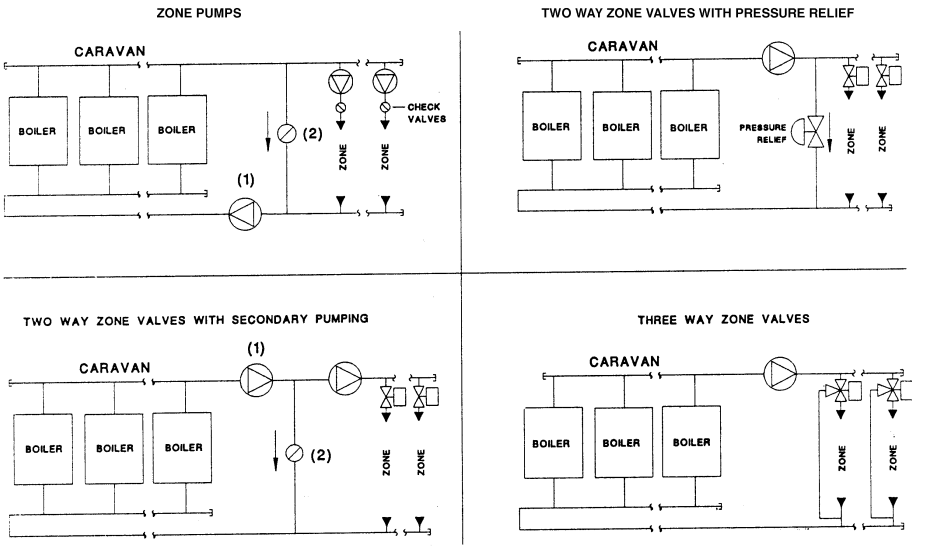
Note: Standard boiler unit prefix is LDWO.

SYSTEM PIPING, CONNECTION DIAGRAMS



* 27" spacing between modules.
† Add 15¼" for dual fuel models.
‡ Dual fuel prefix is LWDF.

Figure 1: Oil Caravan dimensions and typical piping/hot water models



(1) Pump capacity sized for full system GPM. Pump head sized to overcome pressure drop through boiler piping loop only.
(2) Check valve and bypass piping sized for minimum pressure drop. Three inch recommended.

Minimum flow rate formula:
Minimum flow rate through modules =

$$\frac{\text{Gross output (MBH)}}{20{,}000}$$

Note:	A water flow proving device is recommended on all Caravan systems.

Figure 2: Recommended boiler piping for variable volume zone circulation

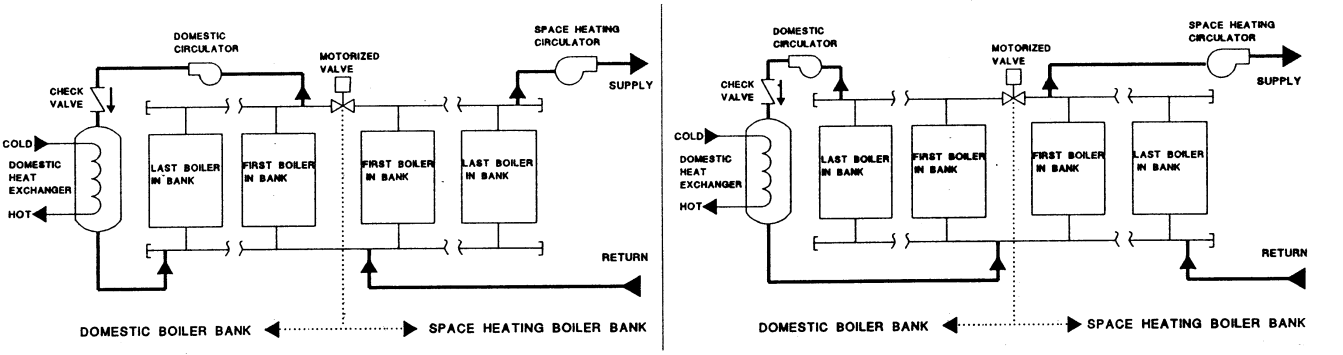


Figure 3: Supply and return piping locations for space heat with domestic hot water

SUGGESTED DOMESTIC HOT WATER PIPING

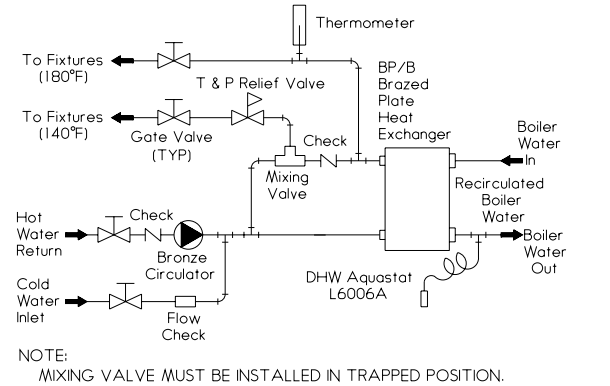


Figure 4: Instantaneous tankless coil—two temperature with recirculation

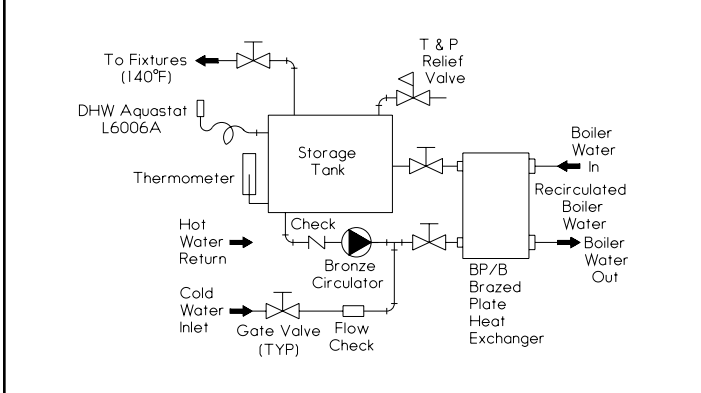


Figure 5: Storage tank from tankless coil with recirculation locations for space heat with domestic hot water

EQUIPMENT INCLUDED
LDWO SERIES — Hot Water Models

Pre-assembled heat exchanger with built-in air separator.
Insulated baked enameled jacket.
Flue collector.
Draft regulator.
Flame retention oil burner with nozzle and CAD cell.
Primary burner control.
Temperature limit.
Flue brush.
Module temperature and pressure gauge.
System pressure and temperature gauge (unmounted-1 per system)
Pressure relief valve (unmounted-1 per module)
Control header (unmounted-1 per system, up to 8 modules)

OPTIONAL EQUIPMENT

Headers.
Control system.

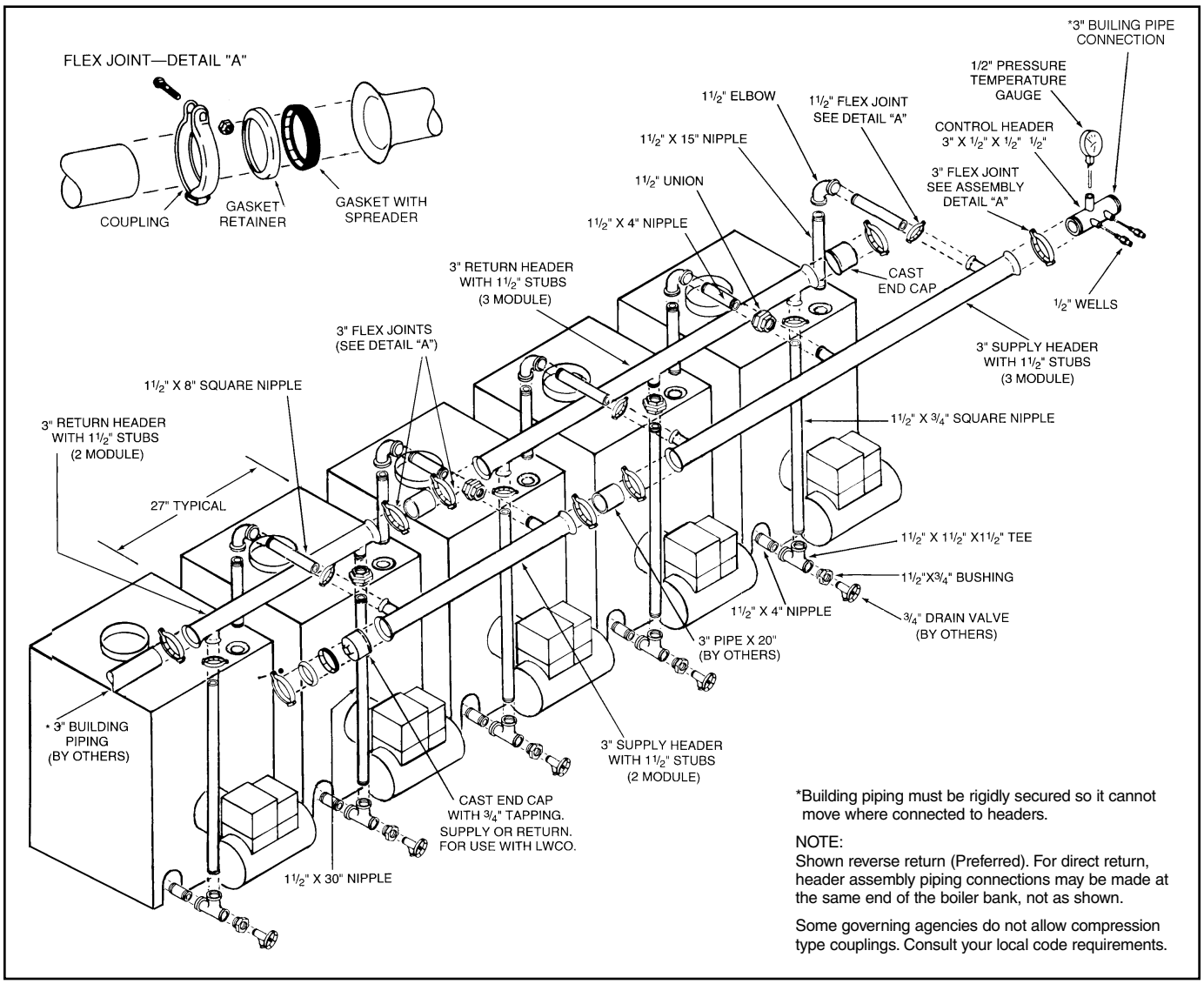


Figure 6: Oil Caravan—optional header assembly for all models LDWO and LWDF hot water Caravan systems.

BOILER ROOM DESIGN

Caravan modular boiler systems allow better utilization of floor space and permit future expansion with minimum cost. Caravan modules are hand truckable, fit through doorways and often may be installed around an existing inoperative boiler. They can be grouped in heating module batteries of single, multiple or angular rows. Oil-fired boiler systems consisting of 9 or more modules should be piped in parallel in two or more batteries. Illustrated below are typical boiler room layouts and dimensional data on the size requirements of oil-fired hot water boilers.

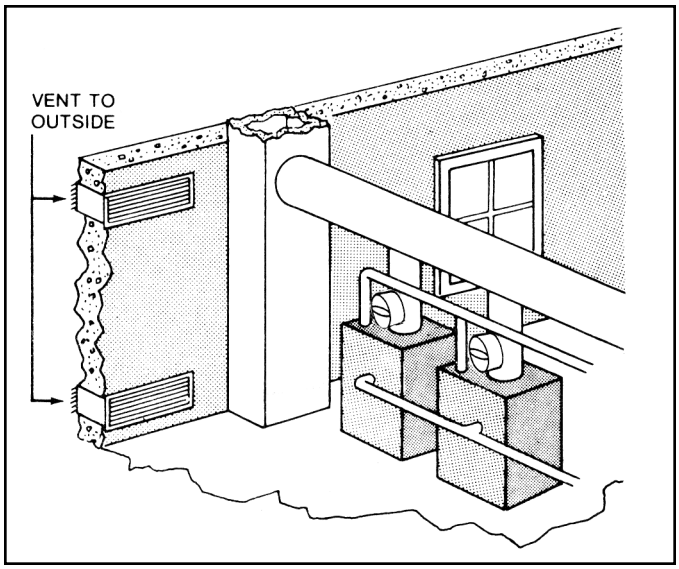


Figure 7. Correct location of combustion-air supply ducts

BOILER ROOM AIR SUPPLY

To ensure safe, efficient operation, the modular boiler system must be supplied with sufficient air to support complete combustion, replacing air entering draft dampers or draft hoods and ventilating the boiler room or areas.
For additional information, not listed below, see ANSI, Z223.1, section 5.3.3.

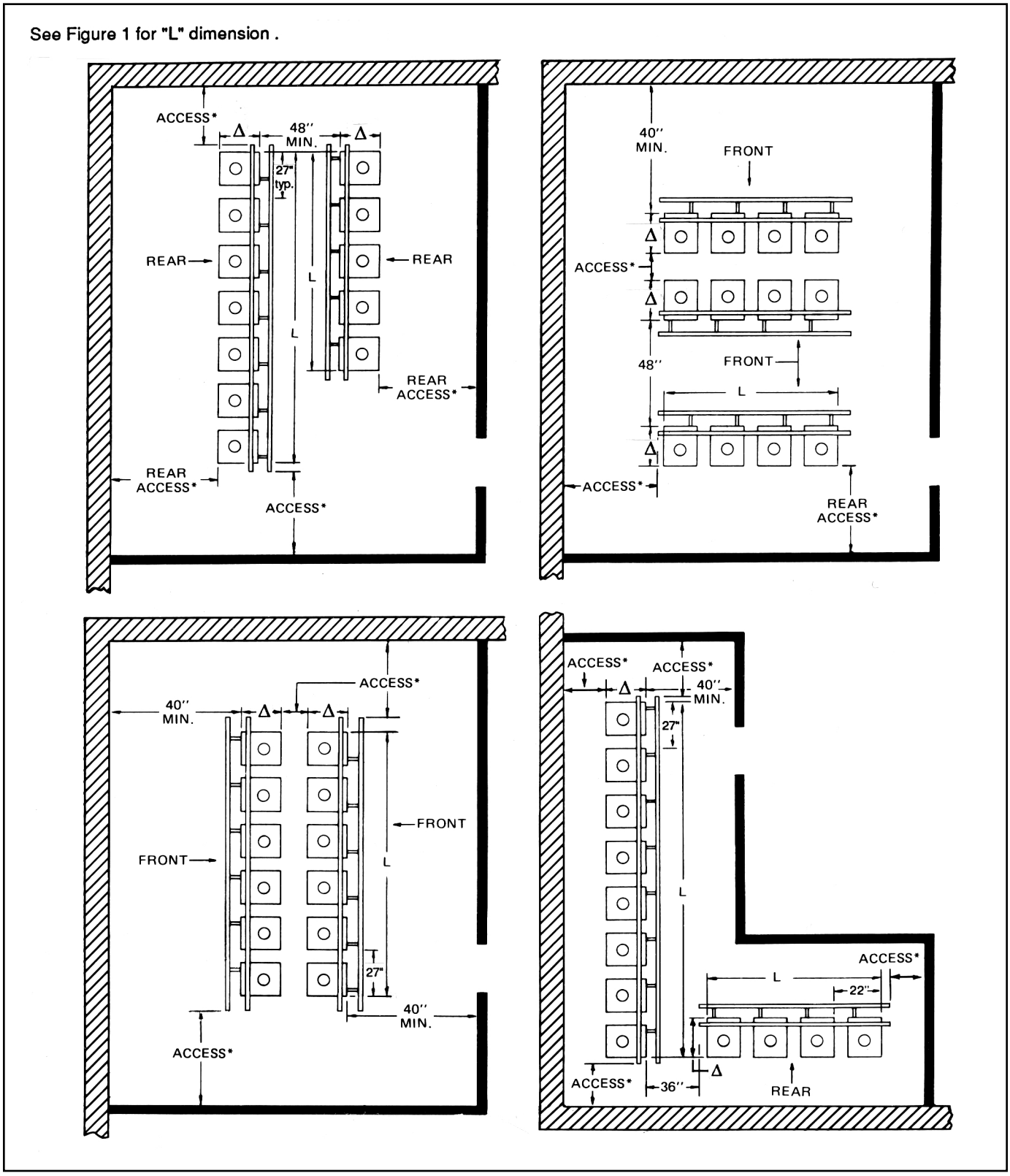
INSTALLATION IN ENCLOSED BOILER ROOM REQUIRES TWO UNOBSTRUCTED OPENINGS FOR PASSAGE OF AIR INTO THE BOILER ROOM:

1. **Air drawn horizontally from outdoors DIRECTLY through an outside wall**; one louvered opening near the floor (below burner inlet) and one louvered opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 4000 BTUH** of total system input.
2. **Air drawn horizontally from outdoors through HORIZONTAL DUCTS**; one opening near the floor (below burner inlet) and one opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 2000 BTUH** of total system input.
3. **Air drawn VERTICALLY from outdoors**; one opening at the floor and one opening at the ceiling, each opening with a minimum FREE air passage area of **1 square inch per 4000 BTUH** of total system input.
4. **Air drawn from inside the building**; one opening near the floor (below burner inlet) and one opening near the ceiling (above the highest draft regulator), each opening with a minimum FREE air passage area of **1 square inch per 1000 BTUH** of total system input.

IF BOILERS ARE INSTALLED ADJACENT TO OTHER FUEL BURNING EQUIPMENT, THE AREA OF FREE OPENINGS MUST BE APPROPRIATELY INCREASED TO ACCOMMODATE THE ADDITIONAL LOAD.

UNLESS PROPERLY CONTROLLED, AVOID THE USE OF FORCED VENTILATION, SINCE IT CAN CREATE AN UNDESIRABLE PRESSURE DIFFERENTIAL BETWEEN BOILER ROOM AND AIR SOURCE.

Figure 8. Typical layouts oil-fired systems



* Caravan can be installed as close as 1" from the wall, local codes permitting. However, 24" is recommended for service inspection access.

Δ See Figure 1 dimensions A and D.

VENTING AN OIL-FIRED SYSTEM

A boiler venting system provides an escape path for the products of combustion. In a venting system for an oil-fired Caravan, there are three major components: a riser with draft regulator for each module, a breeching manifold, and a chimney.

Sometimes the venting system for a boiler plant has to be designed to compensate for inadequate chimney conditions. A mechanical draft inducer, properly sized and installed, can usually increase chimney capacity sufficiently to provide proper venting. Where a draft inducer is called for, consult local codes and the recommendations of the mechanical draft inducer manufacturer. Normally, a draft proving device is necessary to permit operation of the boilers only when adequate draft exists.

It is important to note that when considering a mechanical draft inducer, the boiler room air supply requirements must be increased. Consult the draft inducer manufacturer for this information.

Draft Regulator

The draft regulator compensates for excessive draft that can be caused by varying weather conditions. The regulator should be of the barometric-draft type. Once adjusted for a particular venting system, this type regulator automatically compensates for excessive draft to assure optimum operating efficiency.

Breeching

Breeching is a term used to describe a manifold(s) that connects individual boiler modules to a chimney. Breeching is usually constructed of sheet metal having a smooth interior surface with all joints made tight against leakage. The layout of a particular boiler room may require that the modules be arranged in "batteries" with rows either parallel or at right angles. Minimum breeching sizes are given in Table 2.

Table 2. Breeching dimensions for oil-fired systems — LDWO Series

Model No. *	No. of Modules	Breeching Diameter	Minimum Area (sq.in.)	Breeching Length
LDWO-600-2-5	2	11"	84	4'8"
LDWO-750-2-6	2	12"	101	4'8"
LDWO-850-2-7	2	13"	115	4'8"
LDWO-900-3-5	3	13"	123	7'1"
LDWO-1100-3-6	3	14"	148	7'1"
LDWO-1300-3-7	3	15"	170	7'1"
LDWO-1700-4-7	4	16"	189	9'6"
LDWO-2100-5-7	5	18"	233	11'11"
LDWO-2500-6-7	6	19"	277	14'4"
LDWO-2900-7-7	7	21"	320	16'9"
LDWO-3400-8-7	8	22"	365	19'2"

* Dual fuel prefix = LWDF.

Notes:

1. For breeching and chimney sizing over 8 modules, consult factory.
2. Breeching length should be as short as possible. Measurement from the base of the vertical vent to the nearest connected appliance should be limited to 10' or 50% of the total vent height, whichever is greater.

To avoid creating turbulent air patterns in the breeching, it is suggested that individual boiler vent pipes be connected to the breeching as indicated in Figure 3.

The breeching manifold should extend into, but not beyond, the chimney liner. Round breeching is preferable to rectangular breeching.

Chimney

Caravan oil-fired modular boilers operate efficiently with masonry or prefabricated chimneys. This latter type of chimney construction is generally the least expensive.

Minimum chimney sizes and heights are given in Table 2. In addition, the chimney should be high enough to minimize the effects of turbulent winds and high pressure areas common near roof-top obstructions. The National Board of Fire Underwriters recommends that the chimney should extend 3 feet above the roof and be 2 feet higher than any obstruction within 10 feet (figure 9). The use of a vent cap where permitted by code gives additional protection against adverse wind conditions and precipitation.

Table 3. Chimney requirements

Model No. *	No. of Modules	Chimney Liner Inside Dim. †		
		Dia. Inches	Rectangular L x W Inches	Minimum Height Feet
LDWO-600-2-5	2	11"	9¾" X 9¾"	20'
LDWO-750-2-6	2	12"	9½" X 13½"	20'
LDWO-850-2-7	2	13"	13¼" X 13¼"	20'
LDWO-900-3-5	3	13"	13¼" X 13¼"	20'
LDWO-1100-3-6	3	14"	13¼" X 13¼"	20'
LDWO-1300-3-7	3	15"	13" X 17"	20'
LDWO-1700-4-7	4	16"	13" X 17"	25'
LDWO-2100-5-7	5	18"	16¾" X 16¾"	25'
LDWO-2500-6-7	6	19"	16½" X 20½"	25'
LDWO-2900-7-7	7	21"	20¼" X 20¼"	25'
LDWO-3400-8-7	8	22"	20¼" X 20¼"	25'

* Dual fuel prefix = LWDF.

† Dimensions shown are from ASHRAE Guide Equipment Handbook. Also select inside liner dimensions to give area as great or greater than shown in this table. Chimney height is measured from the center line of the breeching to the top of the chimney. Chimney dimensions are approximate. They are based on use of type "B" double wall vents, connector and manifolds; no manifold elbows or tees; and good vent construction practices.
Field conditions vary. It is doubtful that the chimney dimensions shown here will be suitable for all applications. Consult the 1988 ASHRAE Equipment Handbook and Chimney Manufacturers Sizing Handbook.

Sizing Breeching and Chimneys for Oil-Fired Systems

Breeching for oil-fired Caravan systems can be either constant size or graduated. When constant size breeching is to be installed, refer to Table 2. The use of graduated sections may reduce breeching costs. Generally, it becomes economically feasible to use this approach when boiler batteries exceed four modules. In this case, each breeching section usually serves two to four modules.

To size graduated breeching and chimneys for a Caravan oil-fired modular boiler system, use Table 2 and 3 and the following procedure:

a) Starting with modules in the section furthest from the chimney, count the number of modules venting into that section of breeching.
b) Find breeching necessary to vent these boilers.
c) Count the modules venting into the next section. To this figure add the number of modules from the preceding section, since their output also moves through the second section.
d) Find the correct size breeching for the second section.
e) Repeat steps (c) and (d) for each section until breeching for the entire battery has been sized.
f) If the system has more than one battery, repeat steps (a) through (e) for each battery.
g) Where multiple breeching runs are required, a section of common breeching is often used to join the multiple runs to the chimney. To determine the size of this piece, add up the total number of modules feeding it, and then refer to Table 2 or chimney manufacturer's data.
h) Find the lengths of the various sections of breeching needed for a particular job from Table 2.
i) To calculate the length of the battery-to-chimney breeching section, use the method applicable to the type of breeching as follows:
   - Breeching for only one boiler battery. Measure the distance between the chimney and nearest boiler. Add this to the figure obtained in step (h).
   - Breeching to multiple runs. Measure the distance between the chimney and the first module of the boiler battery that is in the same axis as the common breeching. This is the length of common breeching, measure the distance between side of the common breeching and nearest boiler. Add this to the figure obtained in step (h).
j) To determine the required chimney dimensions, total the number of modules in the system and refer to Table 3. Where building height exceeds the recommended minimum chimney height, refer to chimney paragraph.

NOTE: These procedures DO NOT take into account all possible field conditions. As with all generalized sizing information, the final specifications should be tempered with the engineer's practical experience, and the chimney manufacturer's data, and ASHRAE Handbook.

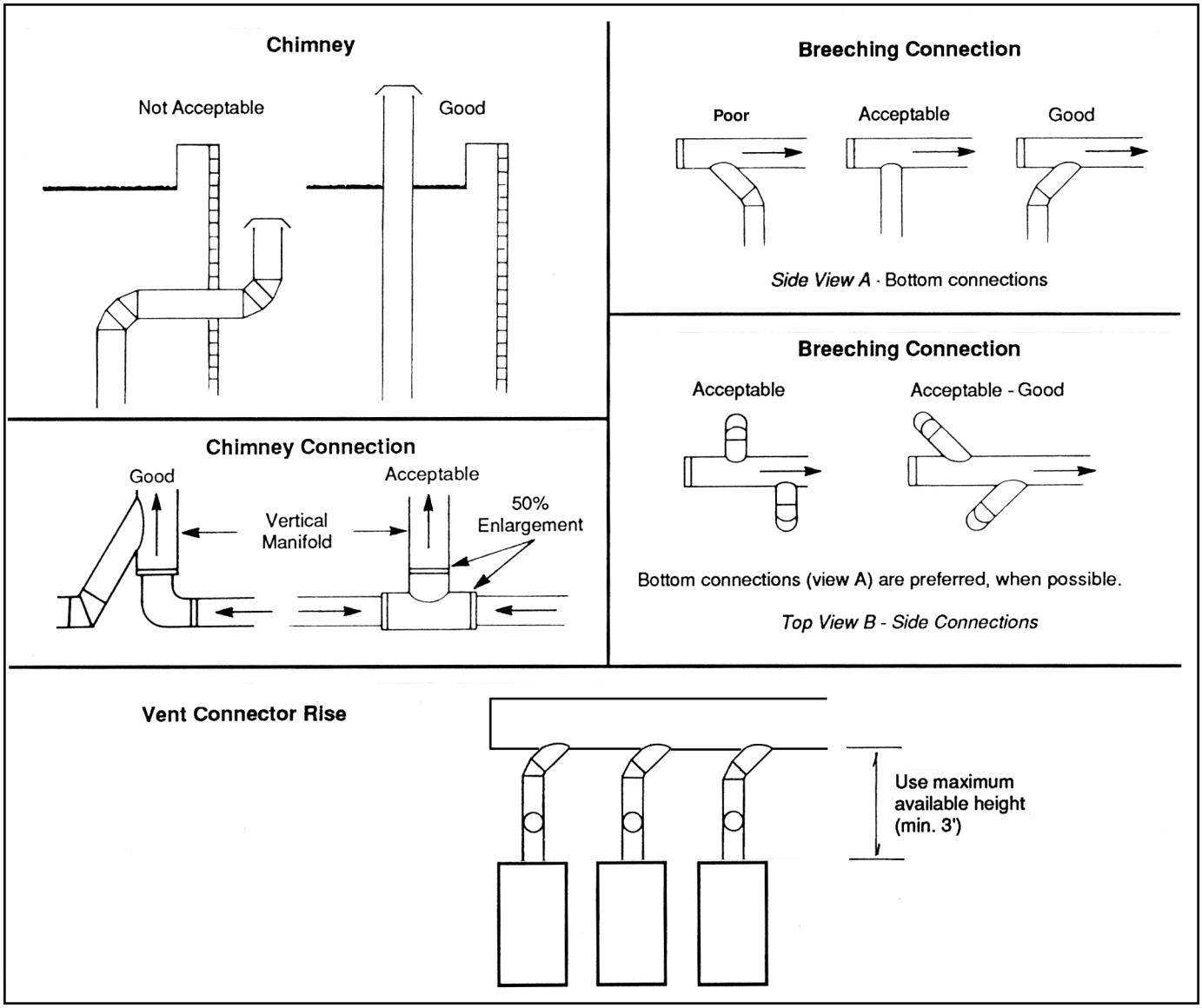


Figure 9. Suggested venting system constructions

FUEL OIL PIPING

FUEL OIL STORAGE FACILITIES

Local codes usually govern the installation of fuel oil storage facilities. However, for areas where no rules have been established, the following information can provide assistance to the system designer.

Storage tank sizing
When calculating minimum fuel oil storage capacity, several variables must be considered. These include: maximum fuel consumption rate, storage space limitations, availability, distance from source of supply, and method of delivery (truck or railroad tank car). Large storage tanks, of course, cost more than smaller ones but the cost is not proportional (e.g., a 10,000 gal. tank does not cost twice as much as a 5,000 gal. tank). And larger tank capacity allows oil purchases usually at lower per gallon rates.

Generally, the storage tank should hold enough oil to sustain continuous operation for 10 days (plus an additional 10% margin to allow for suction stub clearance).

To determine the minimum storage requirement, proceed as follows:
a) Refer to Table 1 to find the maximum hourly oil consumption (GPH) of the system being installed.
b) Multiply the maximum hourly consumption by the probable maximum daily hours of operation to achieve maximum daily consumption.
c) Multiply the maximum daily consumption by 10 (days) and add 10% to obtain the MINIMUM storage capacity.

Requirements for fuel oil storage tanks.
Data in this section is based on the use of steel storage tanks. Where no local codes apply, take the following data into consideration.
a) Inside tanks are usually located in the lowest part of the building. When supply and return lines are piped through the top of the tank, spillage is minimized in the event of leaks.
b) Unenclosed tanks should be at least 7 feet from any open flames or fires.
c) Most fire codes prohibit unenclosed inside tanks exceeding 275 gallons each. Where multiple tanks are installed, the total storage capacity should not exceed 550 gallons unless vaulted.
d) If inside tanks are properly enclosed, the maximum storage capacity can be increased to 5,000 gallons in non-fire-resistant buildings, and to 15,000 gallons in fire-resistant structures.
NOTE: An enclosure shall consist of walls constructed of 6" reinforced concrete or 8-inch thick masonry with the space between tank and walls filled with sand. If floor above has a load-bearing capacity of 150 lbs./sq. inch or greater and is constructed of fire-resistant material, 1 foot of sand fill over the tank is sufficient. If not, a 5-inch concrete slab, or equivalent, must be employed. An alternative method is to pour a 6-inch thick concrete enclosure directly over the tank (no air spaces).
e) Underground tanks (Figure 10) are to be buried at least 2 feet below grade.
f) Tanks buried beneath buildings ALWAYS require 4-inch reinforced concrete slab covers that extend 1 foot beyond tank in all directions.
g) Fiberglass and/or double-walled tanks may be required. Check your local codes. Underground metal tanks should be painted with heavy asphaltum, rust-resistant paint or be of double walled construction (check local codes). DO NOT install tank in bed of cinders (cinders contain sulphur, which becomes corrosive when wet).
NOTE: Before installing underground tanks, check local surface water conditions. Where potential problems exist, concrete anchors should be provided.

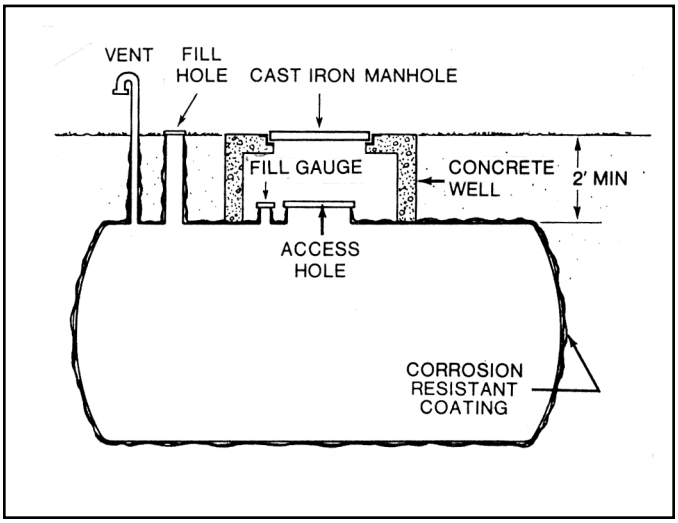


Figure 10. Typical example of properly installed underground fuel tank

FUEL OIL DELIVERY SYSTEMS FOR SINGLE FUEL BURNERS

General
Three methods for delivering oil to the individual burners are described herein. These methods are chosen to provide tempered, filtered and air-free oil to the individual burners. Consistent oil quality will optimize burner operation over longer periods.

There are variations to the methods described herein which, if applied properly, will result in acceptable operation. These methods are for reference only. Local codes vary. It is important to check all codes for compliance.

Information herein has been compiled using data from industry sources, including companies such as Mitco, Webster, Suntec and Tuthill. For additional information on these products, contact the representative in your area.

MFG data and safety codes vary with regard to maximum fuel unit inlet pressure. Pay particular attention to the gravity oil head. Be sure to add oil pressure reducing valves in the event that codes or MFG data will be exceeded. 5 psi is equivalent to approximately 12 feet in height. (See "H" dimension.)

Storage tank above burners (Figure 11)
A simple one pipe connection from the supply tank to each burner helps to eliminate air in the oil line and tempers the oil in the pipe as it travels slowly to the burners.

This method maintains consistent fuel oil quality to the individual burners and therefore decreases the frequency of maintenance and service. When a component breakdown occurs in a burner or in the supply system, the trouble is easily found and service is restored quickly.

Storage tank below burners and gravity tank above burners (Figure 12)
Oil is automatically and constantly maintained in the supply tank at a level sufficient to meet all burner needs. As oil is used, the pressure drop is sensed by a pre-set automatic pressure switch, which signals the booster pump to restore proper level. There is no practical limit on the height or distance that the motorized pump can deliver oil to the supply tank.

The great advantage of the booster pump along with a gravity tank is that it accomplishes its purpose in the most simple and direct manner. This results in the most economical installation, with the shortest possible runs of pipe and wire. It also enables the installer to adapt with ease to almost any building configuration. A simple one pipe connection to each burner helps eliminate air in oil line with constant flow of fuel and tempers the oil.

Simplicity of operation of the individual burner decreases the chances that service will be needed. When a component breakdown occurs in a burner or in the supply system, the trouble is easily found and service is restored quickly.

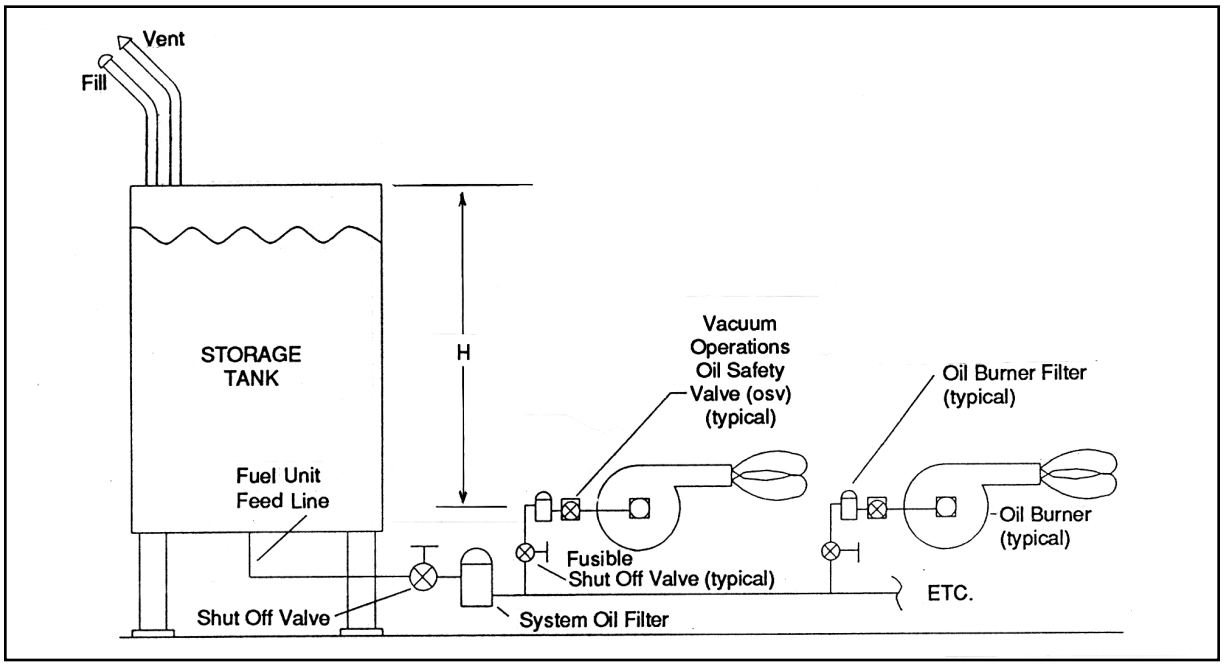


Figure 11. Storage tank above burners

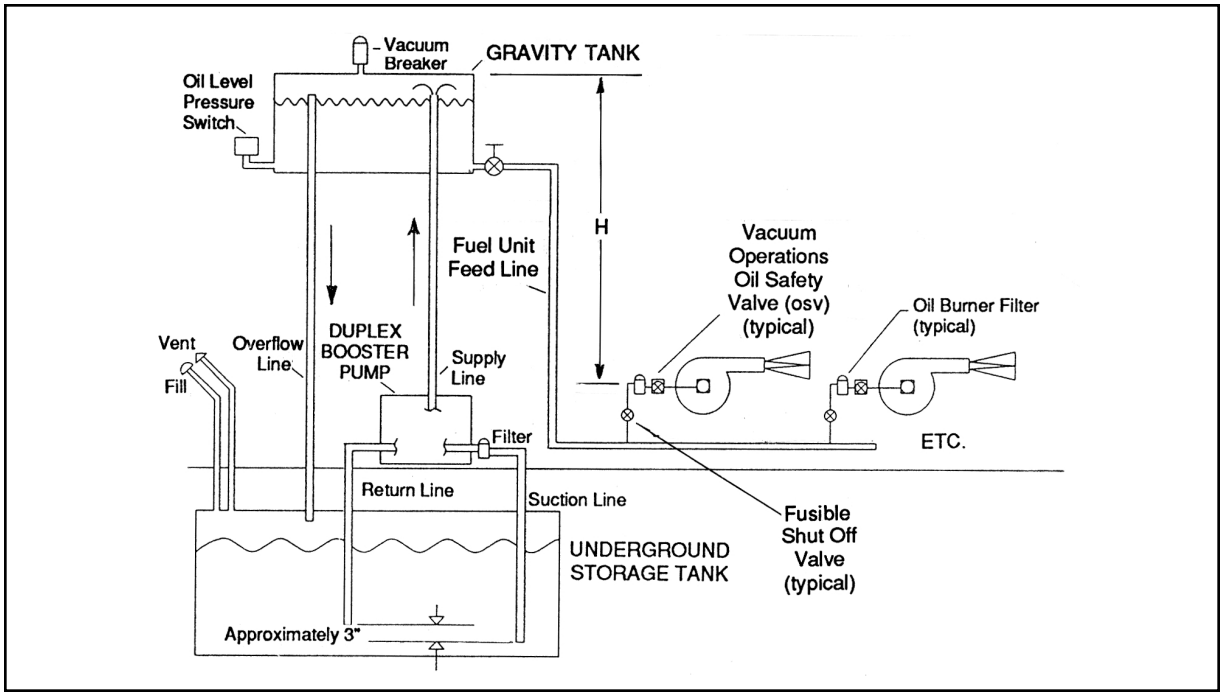


Figure 12. Storage tank below burners

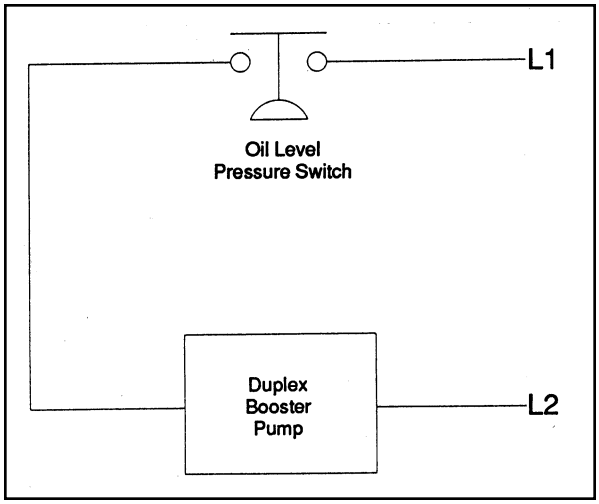


Figure 13. Wiring diagram for gravity feed booster-pump operation

Components usually required are a motorized booster pump of sufficient capacity, gravity tank and mounting hardware, automatic oil level pressure switch, vacuum breaker and necessary check valves and fittings. Additional information can be obtained from Mitco Manufacturing, Hicksville, New York.

Duplex booster pumps are desirable to provide standby capability, in the event of booster pump failure.

Sizing booster pump

To determine the correct size of a booster pump:

a) Using Table 3, find maximum total firing rate of the boiler system being installed.
b) Find the vertical and horizontal dimensions of the booster pump's suction line.
c) Make sure the suction line lift and length are with capabilities of typical booster pumps. Refer to Table 4. (This data is based on Suntec models BH-1030M at 30 GPH, and BH-1050M at 50 GPH or equivalent.)
NOTE: If lift is excessive (max. "Hg one stage, 15" Hg two stage), contact pump manufacturer with exact requirements. If total length is too long, increase suction line diameter.
d) Using Table 5, find correct supply line size.

Table 4. Maximum booster pump suction line length (1)

Vertical Lift (2)	Maximum Total Suction Line Lengths (3) 1/2" O.D. copper tubing (4)	
	Firing Rates up to 30 GPH (5)	Firing Rates up to 50 GPH (6)
0 - 7'	100'	63'
8 - 10'	80'	53'
11 - 13'	63'	41'
14 - 15'	52'	34'

Table 5. Supply line sizes for high-volume fuel oil delivery systems (7)

Firing Rate	Maximum Total Supply Line Length (8)		
Up to 30 GPH (5)	300'	800'	2500'
Up to 50 GPH (6)	175'	350'	1500'
Supply Line Size	½" O.D. tube	½" pipe	¾" pipe

Table 6. Boiler feed line sizes (9)

Total Length Maximum	Firing Rates up to 30 GPH (5)	Firing Rates up to 50 GPH (6)
25'	½" O.D. tube	½" O.D. tube
75'	½" pipe	½" pipe
200'	¾" pipe	¾" pipe

(1) Defined as the connection distance between storage tank and inlet of booster pump.
(2) Height of booster pump inlet above bottom of storage tank. If higher lift is needed, contact booster pump manufacturer with exact requirements.
(3) Total suction length equals vertical lift plus horizontal distance between suction line connection at storage tank and inlet of booster pump.
(4) 5/8" tubing allows maximum horizontal distance between supply tank outlet and booster pump inlet to be safely increased by 250%.
(5) Maximum fuel oil consumption rate with Suntec BH-1030M pump.
(6) Maximum fuel oil consumption rate with Suntec BH-1050M pump.
(7) Supply line is defined as the connection between the outlet of the booster pump and the inlet of the supply tank.
(8) Total supply line length equals vertical lift plus horizontal distance between booster pump outlet and supply tank inlet.
(9) Boiler feed line is defined as the connection between the gravity feed tank and the furthest burner.

FUEL OIL DELIVERY SYSTEMS FOR DUAL FUEL BURNERS

GENERAL

Dual fuel burners are shipped separately and must be field mounted and wired. Connections to Slant/Fin control systems can be found in the control section of this manual.

Burner set-up and mounting instructions are shipped with each dual fuel burner. The installer must follow these instructions.

Dual fuel burners require specific types of fuel oil piping systems. The fuel oil pump is active during gas and oil operation. Since no oil flows to the burner during gas operation, a two pipe system keeps fuel oil in circulation, preventing pump overheating and thermal expansion.

Figures 14 and 15 illustrate two types of two pipe fuel oil delivery systems for dual fuel burners.

If the system is gravity feed, or if the lift is 12' or less, a single stage pump may be selected. If the lift is 18' or less, then a two stage fuel pump should be used. If the lift is more than 18', use a pseudo two pipe loop system (Figure 15).

TWO PIPE SYSTEM (Figure 14)

An important factor to consider in a two pipe system is the line size which depends on the maximum line length and the total oil volume. The gear capacity of the pump is normally quite high compared to the pump's marked capacity. For example, an "A" pump marked for 3 GPH could have a gear capacity of 17 GPH at 3450 RPM.

For a Caravan system, it is ideal to have individual supply and return fuel lines for each boiler. In practice, one can opt to have not more than 3 boilers on a single supply or suction line and a common return for 6 to 9 boilers . (Figure 14)

Table 8 is the calculated line lengths for two types of "B" pumps with different gear capacities. For example, if the lift is 10', the furthest boiler 150' and the fuel oil pump is two stage, of type B89 series, then the corresponding line length from the table is 161' for 5/8" tubing.

NOTE: NFPA requires that the pump inlet pressure not exceed 3 psi. Therefore, when oil is fed by gravity from above the pump, the height should not be more than 8' from the pump to the top of fuel oil supply. If it is more than 8', then one way to protect the pump is to have a vacuum operated safety valve (OSV) on each fuel unit.

PSEUDO TWO PIPE LOOP SYSTEM (Figure 15)
Another way to prevent overheating and thermal expansion of the oil while the unit is running on gas for extended periods, is to use a pseudo two pipe loop system (Figure 15). This system uses a booster pump to circulate the oil from the tank to a header that feeds the burners. Excess oil is fed back to the tank. Generally, a 1/2" fuel line should handle most installations within 200' when using a type "A" pump. A duplex pump-motor boost system should be wired to run for oil as well as for gas. Whenever a burner (regardless of fuel) is running, one of the duplex pump motors should be activated and another pump motor should serve as an automatic backup.

Table 7. Dual Fuel Caravan Ratings Hot Water Models - LWDF Series (75 psi maximum working pressure)

Model No.	No. of Htg. Mod.	Fuel	Firing Rate CCFH GPH	Ratings					Water Content (gal.)	Ship Wt.	Recommended Header Size§
				Input	Gross Output	‡ EDR Water (Sq. Ft.)	I=B=R Net (MBH)†	Horsepower			
LWDF-600-2-5	2	Gas Oil	620 4.30*	620 602	500	2900	435	14.9	31.0	1650	2"
LWDF-750-2-6	2	Gas Oil	750 5.20*	750 728	592	3433	515	17.7	35.6	1870	2"
LWDF-850-2-7	2	Gas Oil	800 6.00*	800 840	622 674	3607	541 586	18.6 20.1	45.2	2080	3"
LWDF-900-3-5	3	Gas Oil	930 6.40*	930 896	750	4347 3680	652 682	22.4	46.5	2475	3"
LWDF-1100-3-6	3	Gas Oil	1125 7.80*	1125 1092	888	5147	772	26.5	53.4	2805	3"
LWDF-1300-3-7	3	Gas Oil	1200 9.00*	1200 1260	933 1011	5407 5860	811 879	27.9 30.2	67.8	3120	3"
LWDF-1700-4-7	4	Gas Oil	1600 12.00*	1600 1680	1244 1348	7213 7813	1082 1172	37.2 40.3	90.4	4160	3"
LWDF-2100-5-7	5	Gas Oil	2000 15.00*	2000 2100	1555 1685	9013 9767	1352 1465	46.4 50.3	113.0	5200	3"
LWDF-2500-6-7	6	Gas Oil	2400 18.00*	2400 2520	1866 2022	10820 11720	1623 1758	55.7 60.4	135.6	6240	3"
LWDF-2900-7-7	7	Gas Oil	2800 21.00*	2800 2940	2177 2359	12620 13673	1893 2051	65.0 70.5	158.2	7280	4"
LWDF-3400-8-7	8	Gas Oil	3200 24.00*	3200 3360	2488 2696	14420 15627	2163 2344	74.3 80.5	180.8	8320	4"

* Light oil, 140,000 Btuh per gallon.
† Net ratings are based on a piping and pick-up allowance of 1.15.
Slant/Fin should be consulted before selecting a boiler for installation having unusual piping and pick-up requirements.
‡ Based on 150 Btuh per square foot E.D.R. at 170°F average water temperature.
§ Modules in excess of 8 are piped in parallel to first eight.

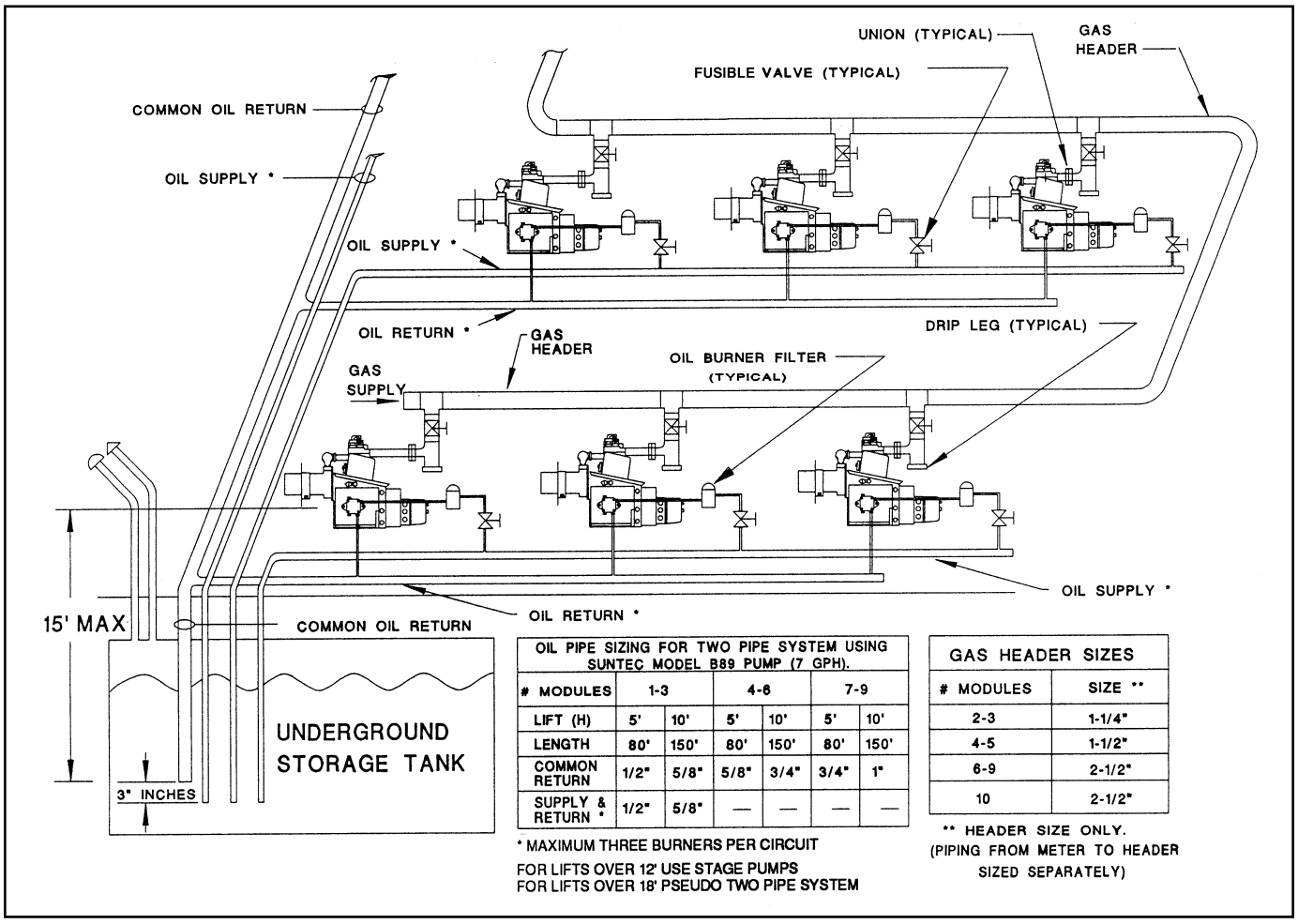
For larger sizes, use multiples of the above.

Table 8. Line Length for Two-Stage Fuel Unit

Two Pipe Lift Ht.	1/2" O.D. Tubing		5/8" O.D. Tubing	
	A	B	A	B
1'	118	99	328	276
2'	113	95	313	263
3'	107	90	298	250
4'	102	86	283	237
5'	96	81	268	225
6'	91	76	253	212
7'	86	72	238	200
8'	80	67	222	187
9'	75	61	207	174
10'	69	58	192	161
11'	64	54	177	148
12'	58	49	162	136
13'	53	44	147	123
14'	47	40	131	110
15'	42	35	116	98

A = B82 Series Suntec Pump 63 GPH gear capacity.
B = B89 Series Suntec Pump 75 GPH gear capacity.

Figure 14. Dual Fuel Piping Two Pipe



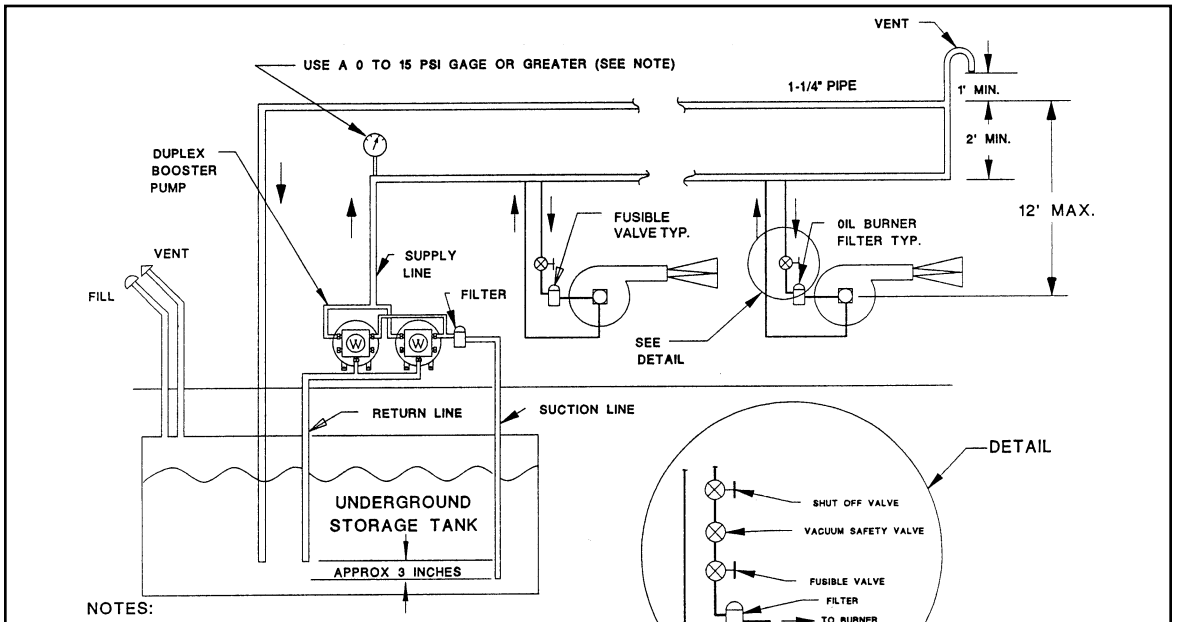
OIL PIPE SIZING FOR TWO PIPE SYSTEM USING SUNTEC MODEL B89 PUMP (7 GPH).						
# MODULES	1-3		4-6		7-9	
LIFT (H)	5'	10'	5'	10'	5'	10'
LENGTH	80'	150'	80'	150'	80'	150'
COMMON RETURN	1/2"	5/8"	5/8"	3/4"	3/4"	1"
SUPPLY & RETURN *	1/2"	5/8"	—	—	—	—

* MAXIMUM THREE BURNERS PER CIRCUIT
FOR LIFTS OVER 12' USE STAGE PUMPS
FOR LIFTS OVER 18' PSEUDO TWO PIPE SYSTEM

GAS HEADER SIZES	
# MODULES	SIZE **
2-3	1-1/4"
4-5	1-1/2"
6-9	2-1/2"
10	2-1/2"

** HEADER SIZE ONLY.
(PIPING FROM METER TO HEADER SIZED SEPARATELY)

Figure 15. Pseudo Two-Pipe Loop System



NOTES:
1) N.F.P.A. Code requires the pump inlet pressure to be under 3 psi. Check your local codes.
2) Be sure to include "H" dimension when calculating the pump inlet pressure.
3) If pump inlet pressure exceeds 3 psi, a vacuum safety valve may be required at each pump.

Detail of oil burner with a vacuum safety valve for systems over 3 psi.

CONTROLS

THE BOILER STAGING CONCEPT

The heart of the Caravan boiler plant is a temperature-actuated control system that automatically stages only those boiler modules needed to meet the heating demand in a given period, thereby conserving fuel.

In a staging control system, each stage ordinarily activates one boiler module. With appropriate wiring, multiple modules can be grouped within a stage.

During a fluctuation in heating requirements, a large central boiler cycles on and off to match heat output to building demand. A staged modular boiler system, on the other hand, will energize only as many modules as the system load requires. Only one stage cycles at a time. The other stages remain off or operate continuously, thereby performing at peak efficiency. For example, in a 10 module boiler system, with the heating load at 61% of capacity, six of the modules operate continuously at peak efficiency. Fractional heating requirements are supplied by the seventh "cycling" module, while the remaining three modules are "off." This is in contrast to a single large central boiler that simply cycles on and off, resulting in lower efficiency.

Over-sizing is a major factor in poor system efficiency. Most of the time a single central boiler is oversized. Historical data shows that many single central boilers are considerably oversized even at the outdoor temperature for which they were designed. Modular boiler systems are not oversized by more than a portion of one module, regardless of the load.

The Caravan control system automatically compensates for seasonal temperature changes. It energizes more or fewer boilers, depending on changes of outside temperature, system water temperature, or both. Modules save energy by operating in long cycles at full-rated output and maximum efficiency.

CONTROL SYSTEM SELECTION

There are three levels of Caravan System Controls (SC). The choice of one system over another depends on several factors: The type of boilers (hot water or steam, gas or oil), the number of stages and modules involved, and the relative importance of installation costs, fuel economy and occupant comfort as design objectives. Caravan modular boiler control systems are not intended to be the sole building temperature control. Zone controls are required.

400 SERIES CONTROL SYSTEM

The 400 series control system provides staging operation to regulate system water temperature with a fixed-ratio, single stage outdoor reset control. The 400 series control is primarily for small to medium sized (2, 3 or 4 boilers) gas-fired Caravan systems, where lead/lag is not critical. The supply water temperature is automatically adjusted up or down based on outdoor temperature. Multiple outdoor temperature controls actuate the number of heating modules needed, depending on outdoor temperature. These modules are then cycled as a group by the outdoor reset control.

The outdoor reset control has two sensors; one 30 foot long sensor monitoring the outdoor temperature, and one 10 foot long sensor monitoring the system water temperature. The reset ratio is nonadjustable and generally sufficient to provide adequate space heating in most climates.

The SCG400 system control group includes the specified 400 series control panel(s) plus all operating and safety controls listed in the bill of materials.

BILL OF MATERIALS - SCG400

Space heating only

1 — Temperature reset control, T475A, for north wall (with sunshield).
* — Outdoor temperature control, T675A, for north wall (with sunshields). * One for each space heating module, in excess of one.
1 — System enable temperature control, T675A, for north wall (with sunshield).
1 — Low water cutoff, PS-851M-120.
1 — Manual reset hi-limit, L4006E.

Space and domestic hot water heating

1 — Temperature reset control, T475A, for north wall (with sunshield).
* — Outdoor temperature control, T675A, for north wall (with sunshields). * One for each space heating module, in excess of one.
1 — System enable temperature control, T675A, for north wall (with sunshield).
1 — Low water cutoff, PS-851M-120.
1 — Manual reset hi-limit, L4006E.
1 — Domestic hot water, temperature control, L6006A.
1 — Domestic hot water motorized valve, EMV II.

Relays required are to be field furnished. See wiring diagram.

1200 SERIES CONTROL SYSTEM

The 1200 series control system is an extremely accurate and flexible multi-stage microprocessor based control system with automatic lead/lag, designed to sequence heating modules based on outdoor air temperature and supply water temperature. This control is generally applied on systems with up to 10 modules. The SC1200 panel consists of a microprocessor mounted in a sheet metal box with adequate wiring knockouts. The panel is furnished with outdoor sensor and water temperature sensor. In the event of a power failure, the control turns all stages off with a time delay between stages for starting when power is restored. The SC1200 panel has an adjustable reset ratio, control band and set point and controls 2 through 6 stages. When used with the EC1200 4-stage expansion panel, up to 10 stages of operation are provided. Individual stage indicating lights are visible with panel cover removed. Desired number of stages can be set in the field. On systems requiring automatic lead/lag and domestic hot water or for systems with more than 10 modules, the 2000 series control system is recommended. If Domestic Hot Water is used with the 1200 series control system, lead/lag must be disabled.

The SCG1200 system control group includes the specified 1200 series control panel(s) plus all operating and safety controls listed in the bill of materials.

BILL OF MATERIALS - SCG1200
Space heating only — 2-6 modules

1 — Microprocessor, 2-6 stage standard system control panel SC1200.
1 — Outdoor temperature sensor, C7031G.
1 — Supply water temperature sensor, C7170A.
1 — Supply water temperature sensor well and housing, C7031D.
1 — System enable temperature control, T675A, for north wall (with sunshield).
1 — Low water cutoff, PS-851M-120.
1 — Manual reset hi-limit, L4006E.

In addition to the above, the following additional components are provided for systems with 7 to 10 modules.
1 — Microprocessor, 7-10 stage standard expansion control panel, EC1200.

OPTIONAL ACCESSORIES
Pump Control (SC 1200 series only)
- automatic pump failure change-over.
- manual pump selector switch.
- alarm circuit and light.

Test plug kit
- speed up testing and troubleshooting.

Consult factory for other desired options.

2000 SERIES CONTROL SYSTEM

The 2000 series control system is a factory-wired multi-stage microprocessor controlled system which incorporates all the components and features of the 1200 series control system, plus visual display readout and provisions for domestic hot water with automatic lead/lag and night set-back features. The system control panel (SC2000) is a NEMA-1 enclosure with a hinged door and keyed lock. Visible indicator lights identify power, heat and active stages. The components are factory wired to a terminal strip that is clearly numbered for connection to common system components such as system enable temperature control, manual reset high limit, low water cutoff and accessory panels such as dual pump control. Two types of lead/lag are featured:

- LEAD/LAG (FOFO): When all boilers are off and a call for heat occurs, the stage following the last stage off will be the first stage on; use this selection when it is important to evenly distribute boiler operating time.
- STD (FOFO): When all boilers are off and a call fo heat occurs, Stage 1 (closest to the chimney) is always first stage on.

The SCG2000 system control group includes the 2000 series control system panel plus all operating and safety controls listed in the bill of materials.

BILL OF MATERIALS - SCG2000

All SCG2000 Systems Control Groups have the following standard components:

1 — Microprocessor, 2-4 stage deluxe system control panel
OR
1 — Microprocessor, 2-8 stage deluxe system control panel
PLUS
1 — Outdoor temperature sensor and system enabler
1 — Supply water sensor

The SCG2000 System include:
1 — Low water cutoff
1 — Manual reset hi-limit

Other options include:
- Indoor space sensor for non-zoned systems
- Stage relays
- Components for domestic hot water include:
  EMV II motorized valve
  DHW thermostat

Circulators, relays, switches and other wiring devices are provided by contractor.

SCG-400-S-4 CARAVAN CONTROL SYSTEM WIRING DIAGRAM

- **Up to 4 space heating modules**

1. POWER SUPPLY, PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

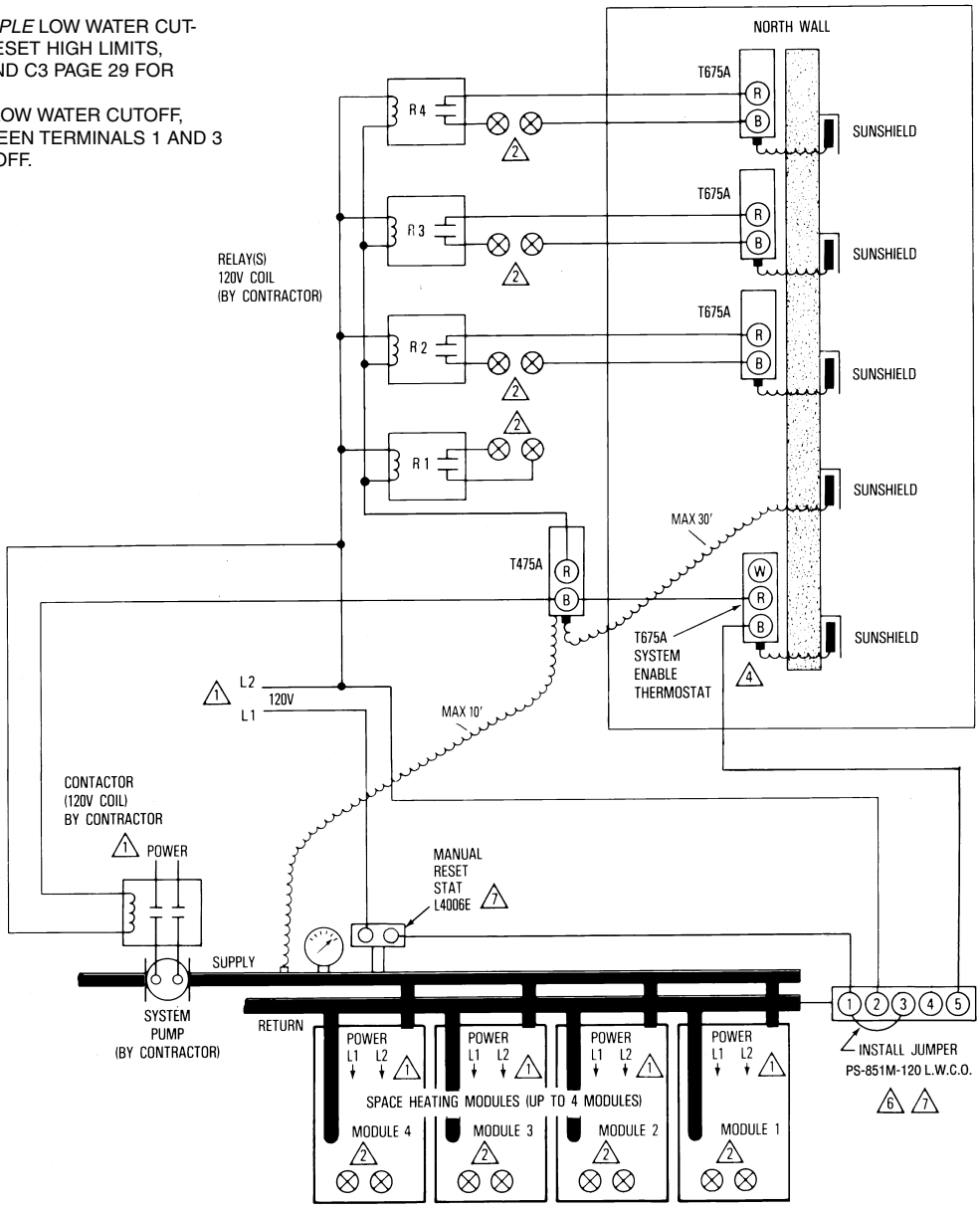
2. SEE FIGURE C1 FOR WIRING TO MODULE ⊗ ⊗ CONNECTIONS.

4. SET SYSTEM ENABLE THERMOSTAT (T675A) AT THE TEMPERATURE THAT THE BUILDING WILL BEGIN TO REQUIRE HEAT (NORMALLY BETWEEN 40° F AND 60° F). MOUNT OUTDOOR SENSING BULB ON NORTH (SHADED) WALL IN SUNSHIELD #34886A.

6. LOW WATER CUTOFFS MUST BE INSTALLED AT A LOCATION HIGHER THAN THE TOP OF THE BOILERS.

7. ON SYSTEMS WITH *MULTIPLE* LOW WATER CUT-OFFS AND/OR MANUAL RESET HIGH LIMITS, REFER TO FIGURES C2 AND C3 PAGE 29 FOR PROPER WIRING.
ON SYSTEMS WITH *ONE* LOW WATER CUTOFF, INSTALL A JUMPER BETWEEN TERMINALS 1 AND 3 ON THE LOW WATER CUTOFF.

T675A SETTING
Determine the proper setting of each T675A thermostat by calculating the percentage of the total heating load that each T675A will energize and apportion this over the operating temperature range (enable temperature minus design outdoor temperature).

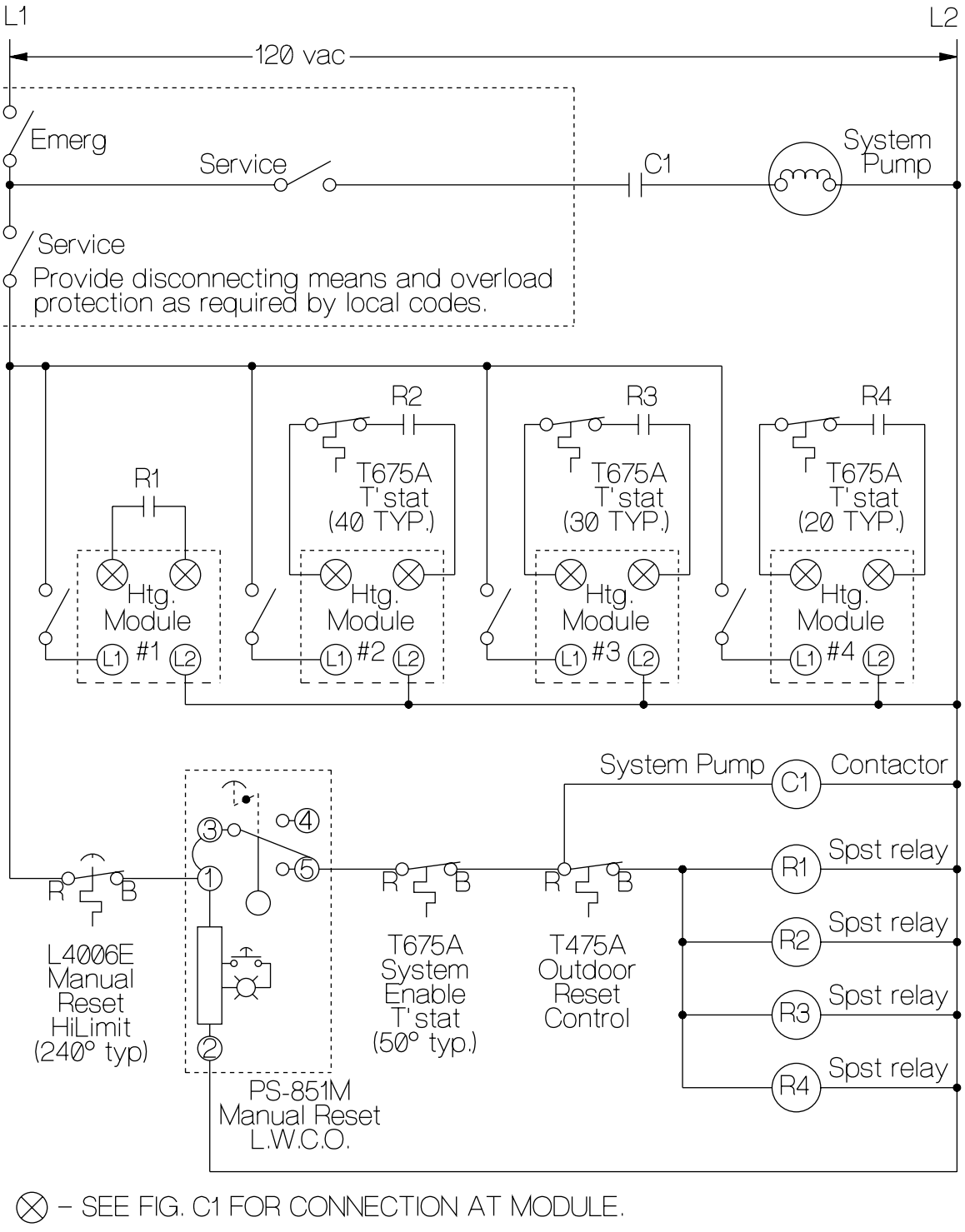


SEQUENCE OF OPERATIONS - SCG400

Space heating only

When outdoor temperature falls below the setting of the system enable temperature control (T675A), the system is activated. The outdoor reset control (T475A) will energize module #1 and regulate the supply water temperature. As the outdoor temperature continues to drop below the settings of the individual module temperature controls (T675A), more stages are energized. The energized modules are cycled as a group by the outdoor reset control (T475A).

SCG-400-S-4 CARAVAN CONTROL SYSTEM LADDER DIAGRAM



SCG-400-D-4 CARAVAN CONTROL SYSTEM WIRING DIAGRAM

• Domestic hot water and space heating

• Up to 4 space heating modules

1. POWER SUPPLY, PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2. SEE FIGURE C1 FOR WIRING TO MODULE ⊗ ⊗ CONNECTIONS.

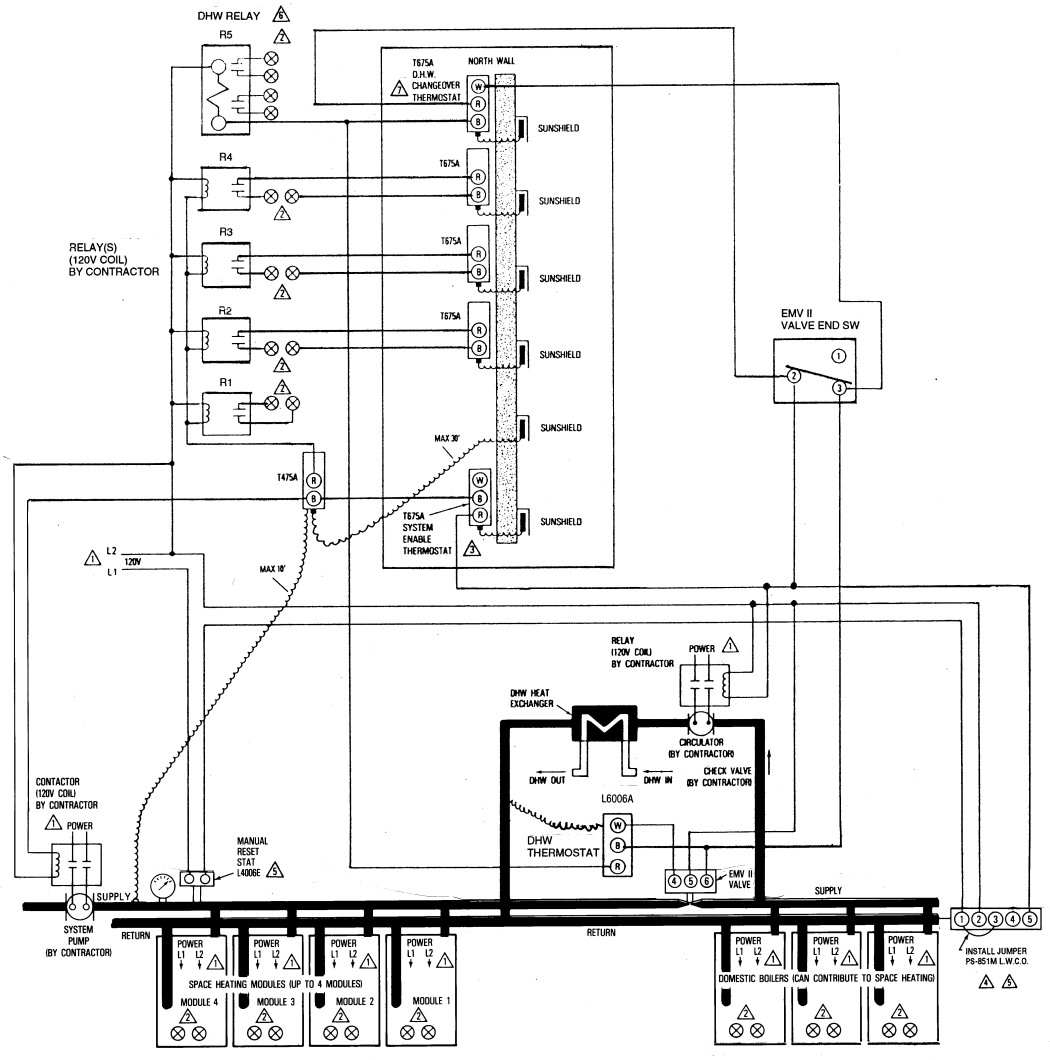
3. SET SYSTEM ENABLE THERMOSTAT (T675A) AT THE TEMPERATURE THAT THE BUILDING WILL BEGIN TO REQUIRE HEAT (NORMALLY BETWEEN 40° F AND 60° F). MOUNT OUTDOOR SENSING BULB ON NORTH (SHADED) WALL IN SUNSHIELD #34886A.

4. LOW WATER CUTOFFS MUST BE INSTALLED AT A LOCATION HIGHER THAN THE TOP OF THE BOILERS.

5. ON SYSTEMS WITH MULTIPLE LOW WATER CUTOFFS AND/OR MANUAL RESET HIGH LIMITS, REFER TO FIGURES C2 AND C3 PAGE 29 FOR PROPER WIRING.
ON SYSTEMS WITH *ONE* LOW WATER CUTOFF, INSTALL A JUMPER BETWEEN TERMINALS 1 AND 3 ON THE LOW WATER CUTOFF.

6. DOMESTIC HOT WATER (DHW) BOILERS CYCLE AS A GROUP THROUGH FIELD SUPPLIED RELAY(S). SEE WIRING DIAGRAMS FOR CONNECTIONS. EACH DHW BOILER REQUIRES A DRY CONTACT CLOSURE. THIS CAN BE DONE WITH INDIVIDUAL RELAY(S) FOR EACH BOILER OR WITH A SINGLE RELAY WITH DRY CONTACTS FOR EACH DHW BOILER(S) AS SHOWN. RELAY(S) ARE FIELD SUPPLIED AND MUST HAVE A 120 VOLT COIL.

7. SET DHW CHANGEOVER THERMOSTAT DESIRED TEMPERATURE FOR DOMESTIC BOILERS TO CONTRIBUTE TO THE SPACE HEATING LOAD.

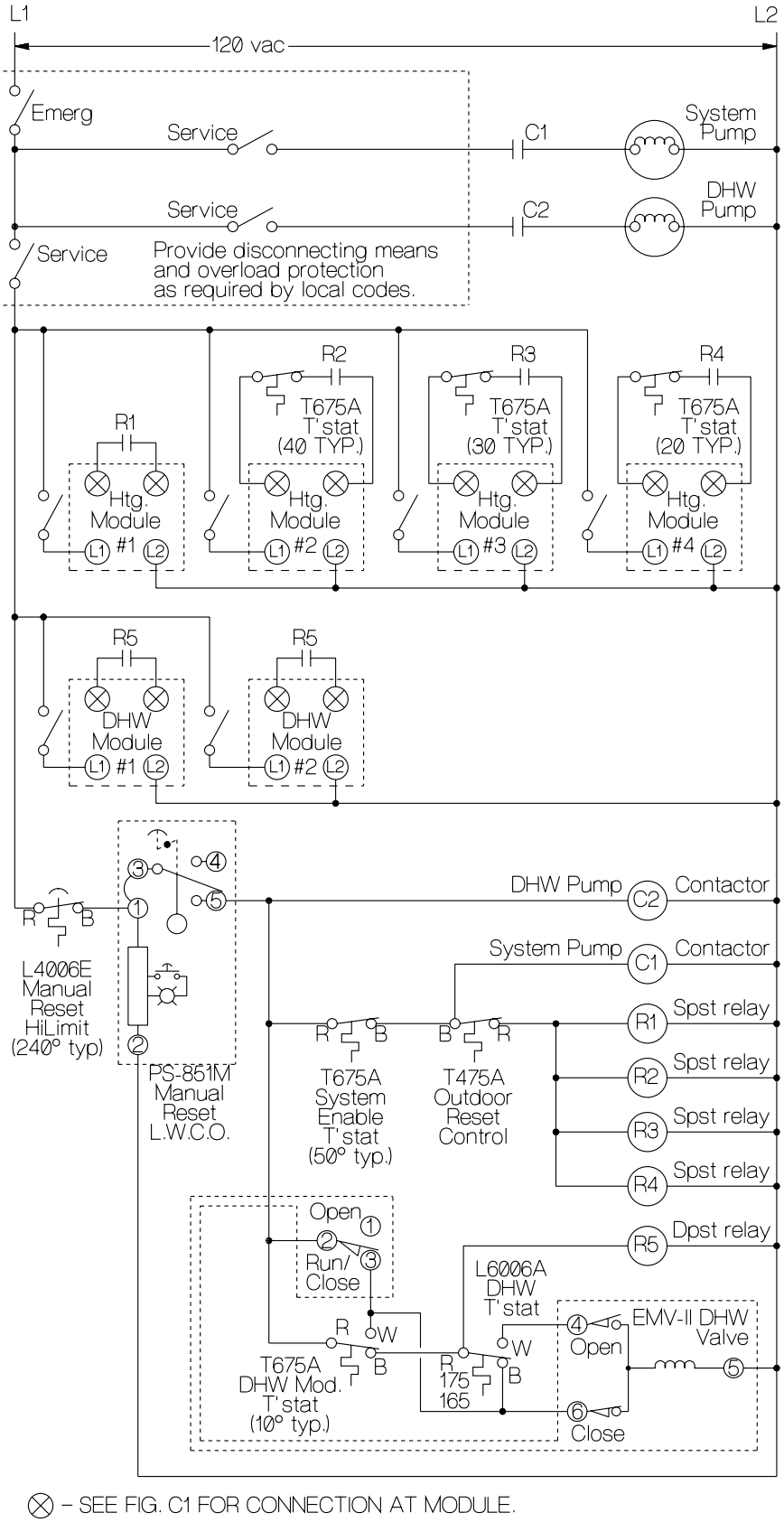


SEQUENCE OF OPERATIONS - SCG400

Space heating and domestic hot water

Domestic modules maintain hot water year round through a L6006A aquastat, mounted in the boiler return pipe of the DHW heat exchanger. When outdoor air temperature falls below the setting of the system enable temperature control (T675A), the space heating system is activated. The outdoor reset control (T475A) will energize module #1 and modulate the supply water temperature based on outdoor temperature. As the outdoor temperature continues to drop below the settings of the individual module temperature controls (T675A), more modules are energized. The energized modules are cycled as a group by the reset control. When the final outdoor temperature control (T675A) calls, and domestic hot water temperature control (L6006A) is satisfied, the motorized valve opens, allowing the domestic water modules to contribute to space heating.

SCG-400-D-4 CARAVAN CONTROL SYSTEM LADDER DIAGRAM



SC-1200-S-06-06 CARAVAN CONTROL SYSTEM WIRING DIAGRAM
• Up to 6 space heating modules
• Up to 6 stages

SYSTEM CONTROLLER SC1200

SC-1200 panel is factory equipped for 6 stage operation. To change the number of operating stages the appropriate resistor must be installed in the SC1200 panel, ***on the microprocessor control,*** across terminals 7 and 8. Resistors for 1 through 5 stages are shipped with the SC1200 panel. Resistors for 7 through 10 stages are shipped with the SC1200 panel. See Table C3.

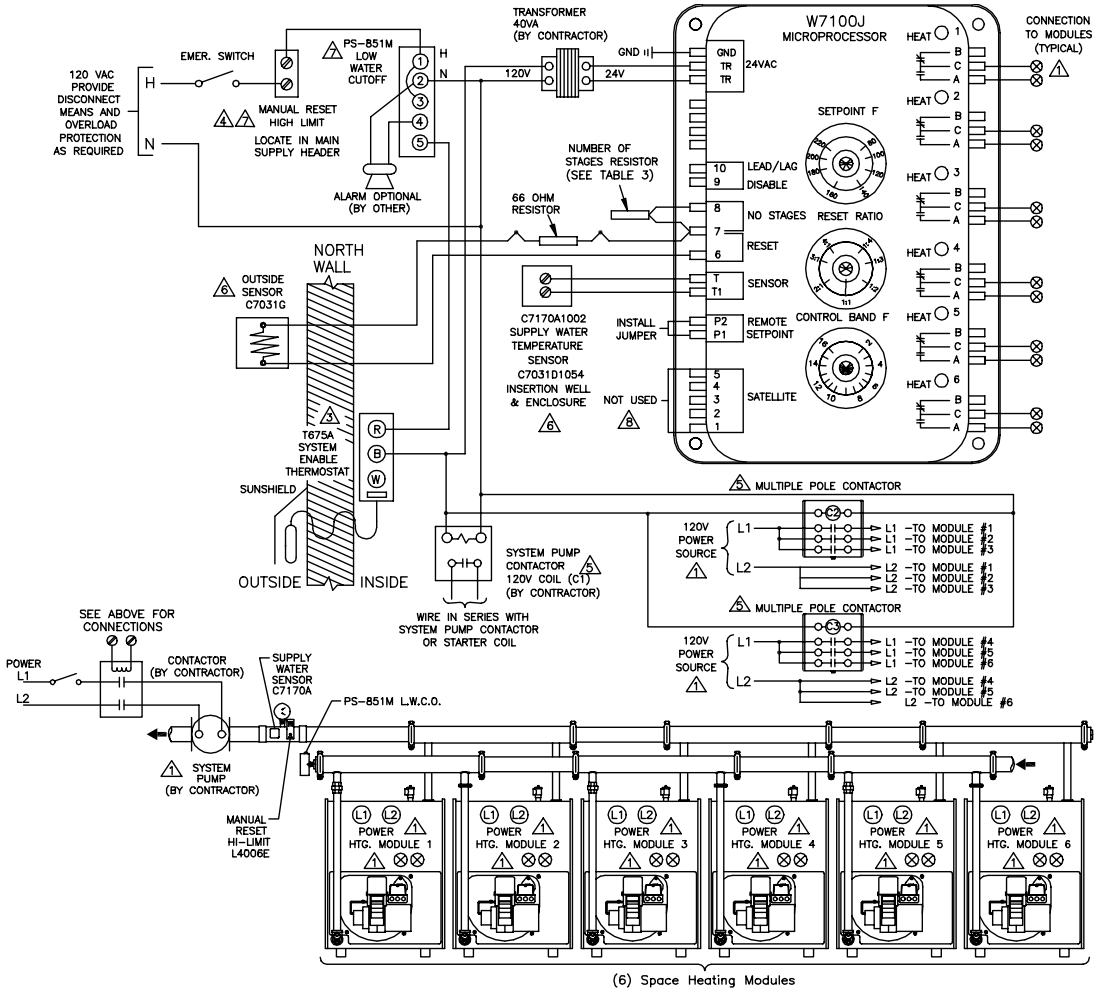
For proper control settings refer to Tables C1 and C2.
Microprocessor control has a two minute time delay between stages. For rapid testing and troubleshooting, the control may be temporarily sped up by using a TP1 test plug kit. Order Slant/Fin part number 411006 (Honeywell part number 4074EDJ).

This control is equipped with automatic lead/lag which constantly rotates the boiler firing order to ensure even wear. The automatic lead/lag function can be disabled by installing a jumper in the SC1200 panel, on the microprocessor control, across terminals 9 and 10.

IMPORTANT

For more detailed information, refer to the manufacturer's data packed with each component.

1. REFER TO FIG. C1 ON PG. 29 FOR WIRING AT MODULES.
2. CONTACTS REFLECT CLOSED VALVE.
3. R AND W MAKE ON TEMP. RISE ABOVE SETPOINT.
4. CONTACT OPENS AT HIGH LIMIT SETTING.
5. RELAYS REFLECT DE-ENERGIZED MODE
6. REMOTE SENSOR (USE SHIELDED CABLE)
7. ON SYSTEMS WITH MULTIPLE LOW WATER CUTOFFS AND/OR MANUAL RESET HIGH LIMITS, REFER TO FIG. C2 AND C3 FOR PROPER WIRING. ON SYSTEMS WITH ONE L.W.C.O. INSTALL A JUMPER BETWEEN TERMINALS 1 AND 3 ON THE L.W.C.O.
8. ASSEMBLED 6" WIRE AND 1/4" FEMALE QUICK CONNECTORS ARE PROVIDED FOR CONNECTION TO FIELD WIRING ON SC1200 AND EC1200 PANELS. (WIRE NUTS BY CONTRACTOR)

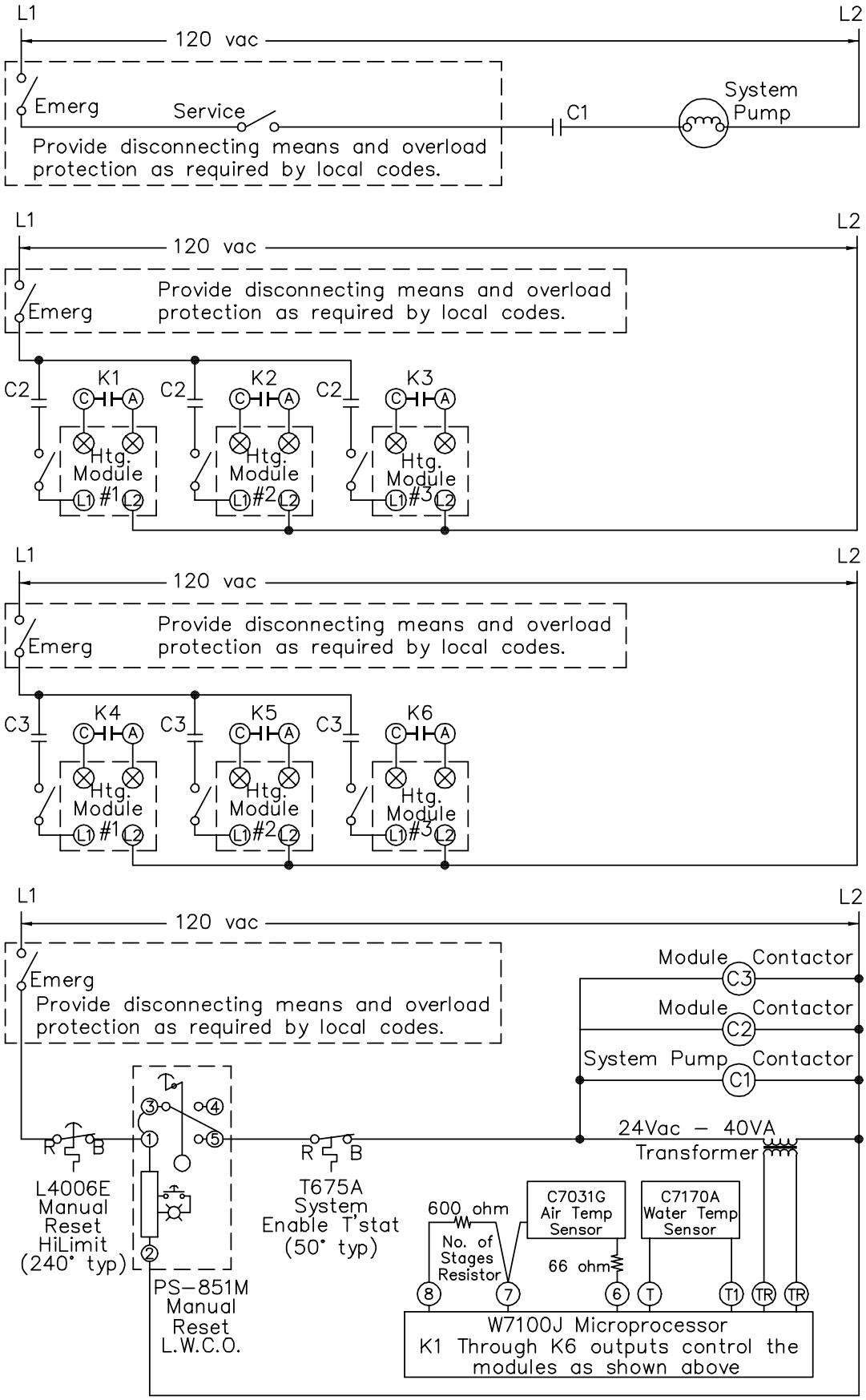


SEQUENCE OF OPERATIONS - SCG1200

Space heating only

When outdoor temperature falls below the setting of the system enable temperature control (T675A), the system is enabled. The 1200 series control system energizes the necessary modules to maintain sufficient supply water temperature based upon outdoor air temperature demand. As outdoor air temperature changes, the system will automatically increase or decrease the number of operating modules until supply water temperature meets outdoor air temperature demand. The control system also operates the boilers with automatic lead/lag, ensuring equal run-time for each boiler. If desired, the automatic lead/lag can be disabled by installing a jumper, on the microprocessor control, across terminals 9 and 10.

SC-1200-S-06-06 CARAVAN CONTROL SYSTEM LADDER DIAGRAM



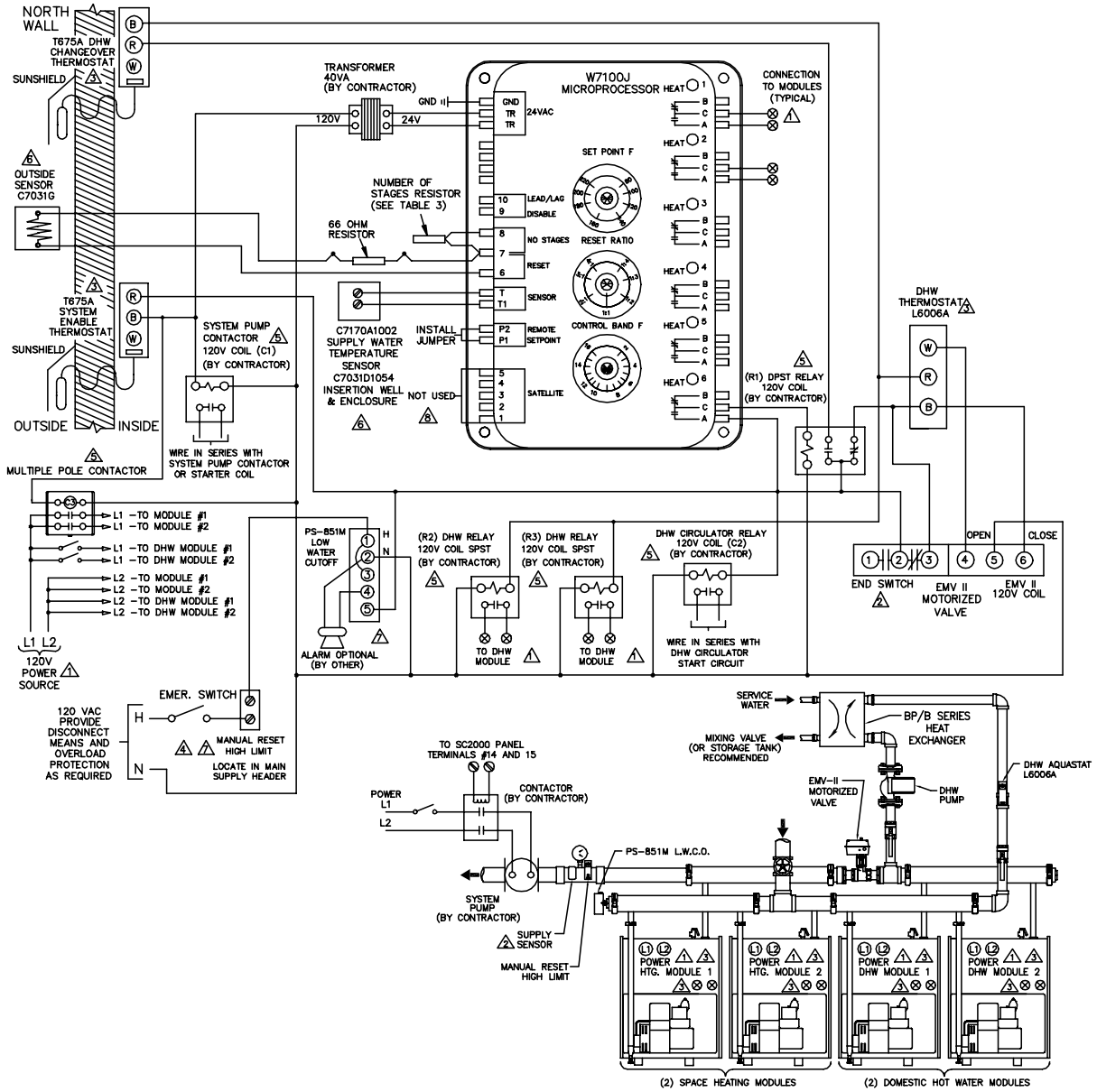
⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

SCG-1200-D-06-04 CARAVAN CONTROL SYSTEM WIRING DIAGRAM

• Domestic hot water and space heating

• Up to 6 space heating modules

1. REFER TO FIG. C1 ON PG. 29 FOR WIRING AT MODULES.
2. CONTACTS REFLECT CLOSED VALVE.
3. R AND W MAKE ON TEMP. RISE ABOVE SETPOINT.
4. CONTACT OPENS AT HIGH LIMIT SETTING.
5. RELAYS REFLECT DE-ENERGIZED MODE
6. REMOTE SENSOR (USE SHIELDED CABLE)
7. ON SYSTEMS WITH MULTIPLE LOW WATER CUTOFFS AND/OR MANUAL RESET HIGH LIMITS, REFER TO FIG. C2 AND C3 ON PG. 29 FOR PROPER WIRING. ON SYSTEMS WITH ONE L.W.C.O. INSTALL A JUMPER BETWEEN TERMINALS 1 AND 3 ON THE L.W.C.O.
8. ASSEMBLED 6" WIRE AND 1/4" FEMALE QUICK CONNECTORS ARE PROVIDED FOR CONNECTION TO FIELD WIRING ON SC1200 AND EC1200 PANELS. (WIRE NUTS BY CONTRACTOR)

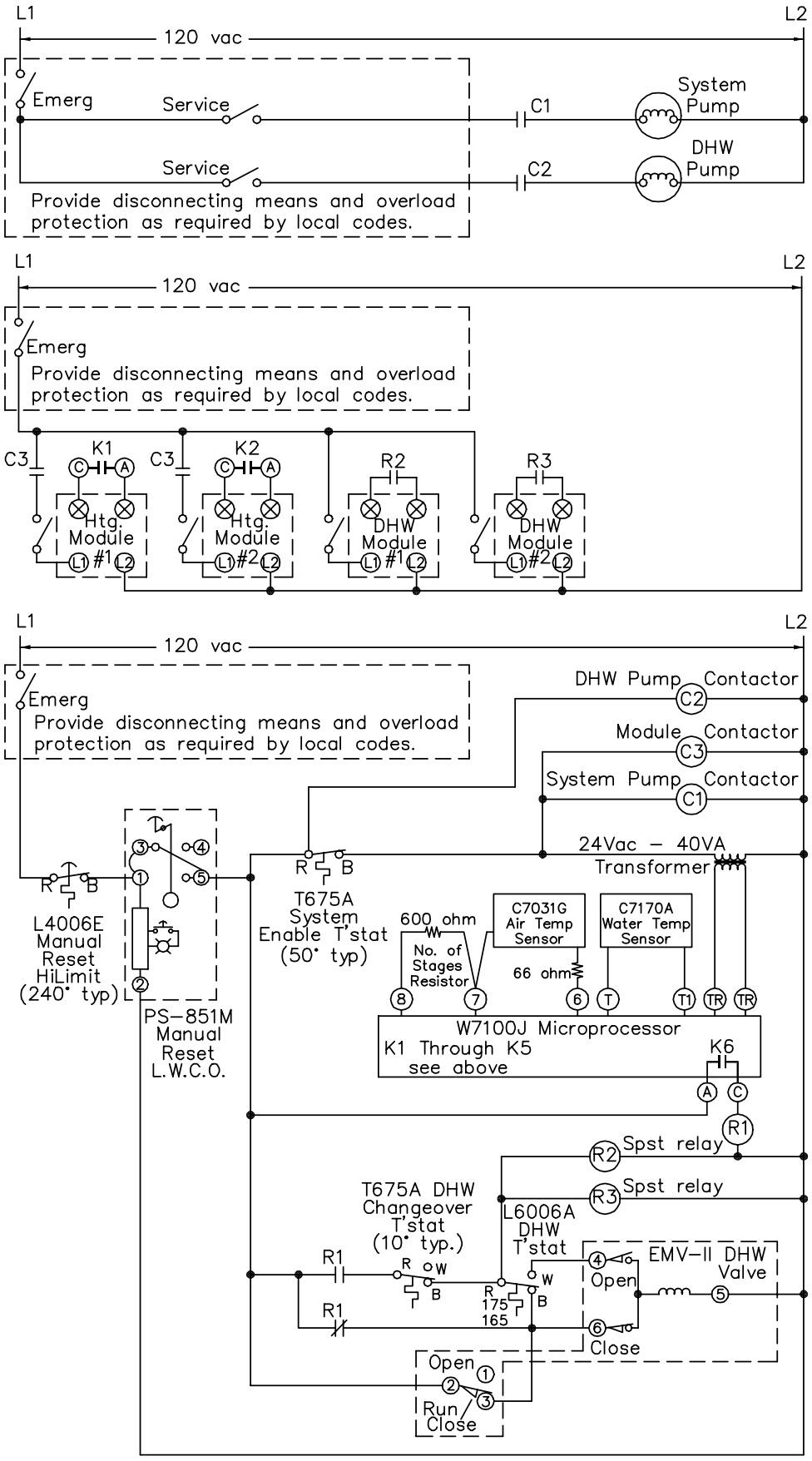


SEQUENCE OF OPERATIONS - SCG1200

Space heating and domestic hot water

When outdoor temperature falls below the setting of the system enable temperature control, the space heating system is enabled. The microprocessor control will energize the necessary modules to maintain sufficient supply water temperature based upon outdoor air temperature. As the outdoor temperature changes, the control system will increase or decrease the number of operating modules to meet the supply water temperature required by the outdoor temperature. The modules operate with automatic lead/lag, first on - first off (FOFO), or lead/lag can be disabled to operate first on - last off. When the outdoor temperature falls below the setting of the outdoor DHW Changeover Thermostat, *and* domestic hot water (DHW) is satisfied, *and* stage 6 is energized, the DHW valve opens, allowing the domestic hot water modules to contribute to space heating.

SCG-1200-D-06-05 CARAVAN CONTROL SYSTEM LADDER DIAGRAM

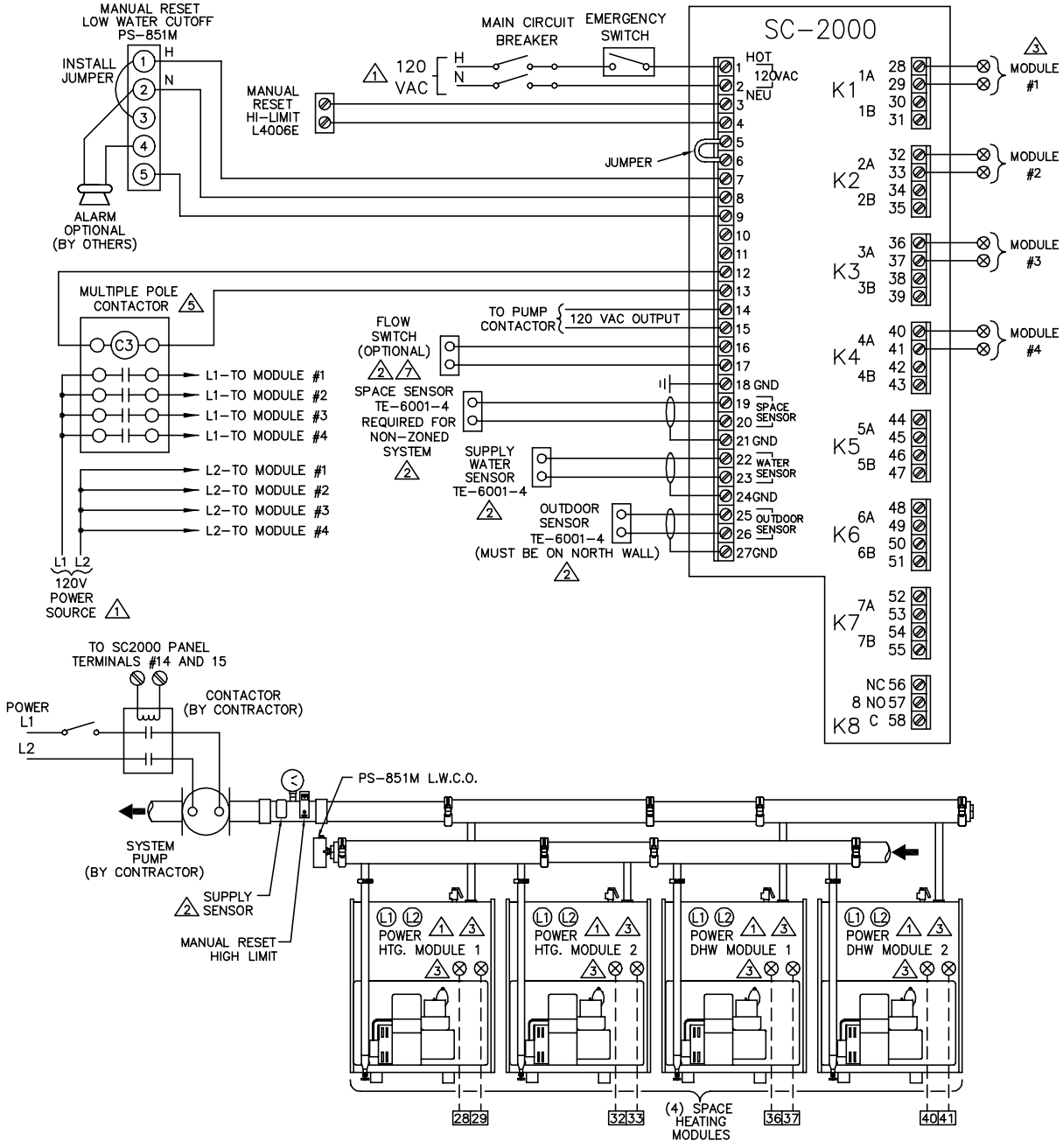


⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

SCG-2000 CARAVAN CONTROL SYSTEM WIRING DIAGRAM

- **Space heating only**
- **Up to 15 space heating modules**

1. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED BY LOCAL CODE.
2. SHIELDED CABLE IS RECOMMENDED WHEN WIRING SENSORS.
3. REFER TO FIG. C1 ON PG. 29 FOR WIRING AT MODULES.
4. WHEN TERMINALS 5 AND 6 ARE JUMPED THERE IS A 120V OUTPUT ON TERMINALS 10 AND 11. WHEN TERMINALS 5 AND 6 AND 16 AND 17 ARE JUMPED THERE IS A 120V OUTPUT ON TERMINALS 12 AND 13. 2.5 AMPS PER TERMINALS 10 AND 11 AND 12 AND 13 TOTAL 5 AMPS MAX.
5. CONTACTORS MUST HAVE ONE NORMALLY OPEN CONTACT PER MODULE AND BE RATED ACCORDING TO MODULE CURRENT LOAD, 6.0 AMPS PER BURNER.
6. 4 SPACE HEATING MODULES SHOWN; UP TO 15 MODULES OF SPACE HEATING MODULES CAN BE CONNECTED.

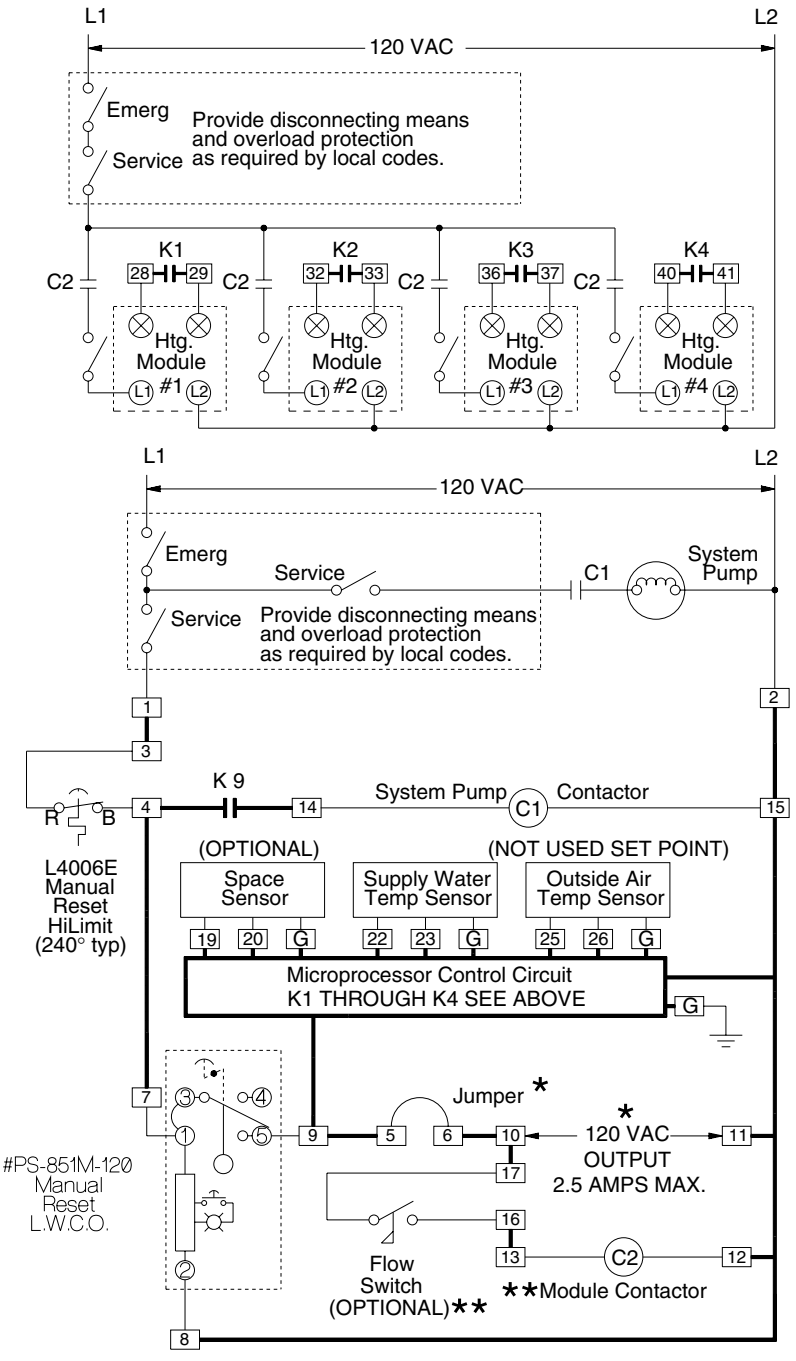


SEQUENCE OF OPERATIONS - SCG2000

Space heating only

When the outdoor temperature falls below the outdoor start temperature setting, the system is enabled. The microprocessor control will energize the necessary modules to maintain sufficient supply water temperature based upon outdoor air temperature. As the outdoor temperature changes, the control system will increase or decrease the number of operating modules to meet the supply water temperature required by the outdoor temperature. The modules operate with automatic lead/lag, first on - first off (FOFO) or, after all boilers are off, stage 1 is first on - then FOFO. A space sensor can be installed (usually with most non-zoned systems). This modifies the selected supply water temperature, to accurately meet the space temperature selected. The control has built-in set-back programming capability.

SCG-2000-4 CARAVAN CONTROL SYSTEM LADDER DIAGRAM



⊗ – SEE FIG. C1 FOR CONNECTION AT MODULE.

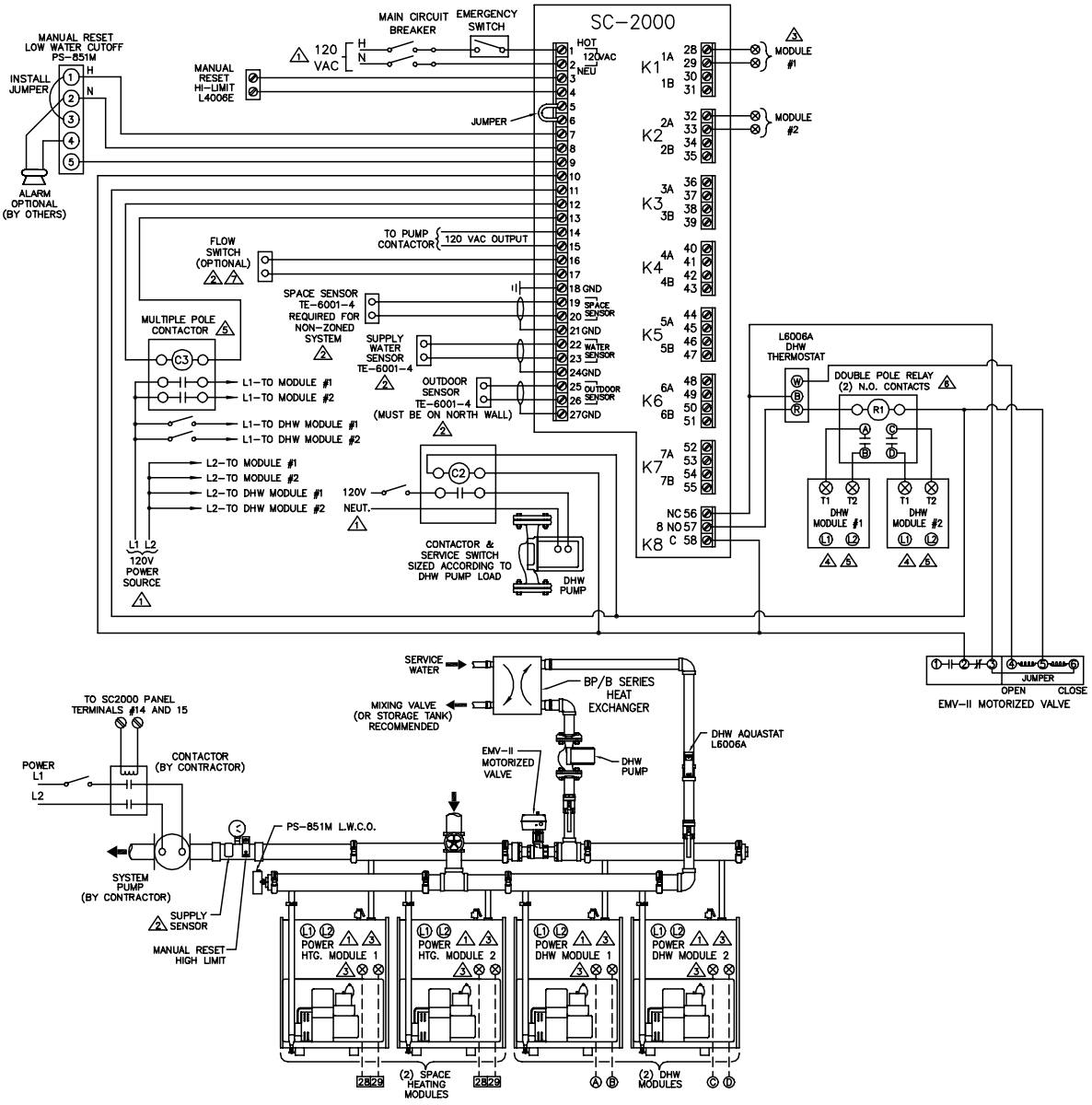
* – 120V OUTPUT ON TERMINALS 10 AND 11 WHEN TERMINALS 5 AND 6 ARE JUMPED.

** – 120V OUTPUT ON TERMINALS 12 AND 13 WHEN TERMINALS 5 AND 6 AND 16 AND 17 ARE JUMPED.

SCG-2000-D-2 CARAVAN CONTROL SYSTEM WIRING DIAGRAM

- **Domestic hot water and space heating**
- **Up to 14 space heating modules**

1. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED BY LOCAL CODE.
2. SHIELDED CABLE IS RECOMMENDED WHEN WIRING SENSORS.
3. REFER TO FIG. C1 ON PG. 29 FOR WIRING AT MODULES.
4. WHEN TERMINALS 5 AND 6 ARE JUMPED THERE IS A120V OUTPUT ON TERMINALS 10 AND 11. WHEN TERMINALS 5 AND 6 AND 16 AND 17 ARE JUMPED THERE IS A 120V OUTPUT ON TERMINALS 12 AND 13. 2.5 AMPS PER TERMINALS 10 AND 11 AND 12 AND 13 TOTAL 5 AMPS MAX.
5. CONTACTORS MUST HAVE ONE NORMALLY OPEN CONTACT PER MODULE AND BE RATED ACCORDING TO MODULE CURRENT LOAD, 6.0 AMPS PER BURNER.
6. RELAY OR RELAYS FOR DHW MODULES MUST HAVE ONE N.O. CONTACT PER MODULE. A DOUBLE POLE RELAY IS PRESENTLY SHOWN. THERE IS A 120V OUTPUT ON TERMINALS 12 AND 13.
7. IF FLOW SWITCH IS NOT USED, TERMINALS 16 AND 17 MUST BE JUMPED TO GET OUTPUT ON TERMINALS 12 AND 13 FOR MODULE CONTACTORS.

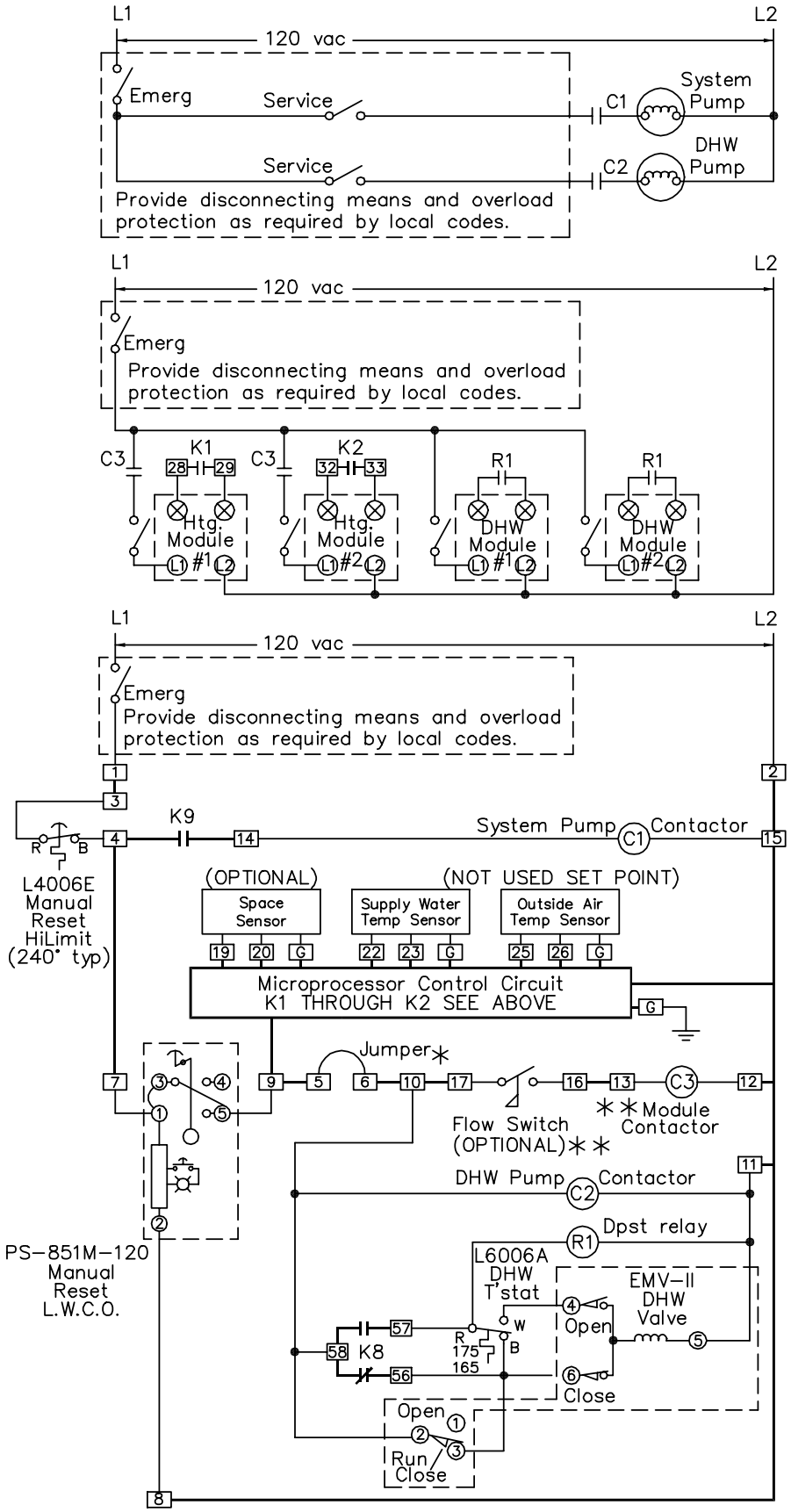


SEQUENCE OF OPERATIONS - SCG2000

Space heating and domestic hot water

When outdoor temperature falls below the outdoor start temperature setting, the space heating system is enabled. The microprocessor control will energize the necessary modules to maintain sufficient supply water temperature based upon outdoor air temperature. As the outdoor temperature changes, the control system will increase or decrease the number of operating modules to meet the supply water temperature required by the outdoor temperature. The modules operate with automatic lead/lag, first on - first off (FOFO) or, after all boilers are off, stage 1 is first on - then FOFO. With all space heating stages energized, if the space load exceeds the stages capacity, *and* domestic hot water is satisfied, the domestic hot water valve will open, allowing the domestic water modules to contribute to space heating. A space sensor can be installed (usually with most non-zoned systems). This modifies the selected supply water temperature selected. The control has built-in set-back programming capability.

SCG-2000 CARAVAN CONTROL SYSTEM LADDER DIAGRAM



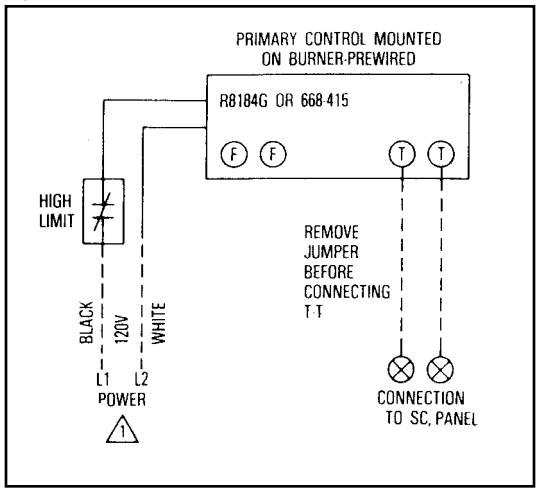
⊗ –SEE FIG. C1 FOR CONNECTION AT MODULE.

* –120V OUTPUT ON TERMINALS 10 AND 11 WHEN TERMINALS 5 AND 6 ARE JUMPED.

** –120V OUTPUT ON TERMINALS 12 AND 13 WHEN TERMINALS 5 AND 6 AND 16 AND 17 ARE JUMPED.

FIELD WIRING AT MODULES

Figure C1. Oil-fired, dual fuel. ***See basic drawing below.***



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

Figure C2. Multiple manual reset high limit wiring (if used).

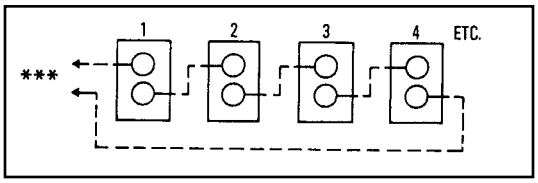
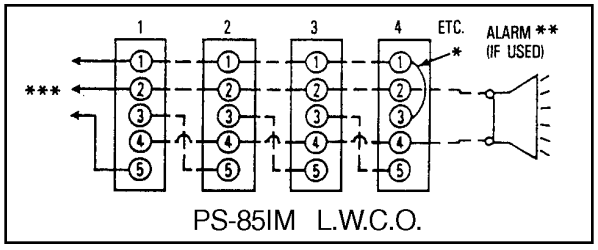


Figure C3. Multiple low water cutoff wiring (if used).

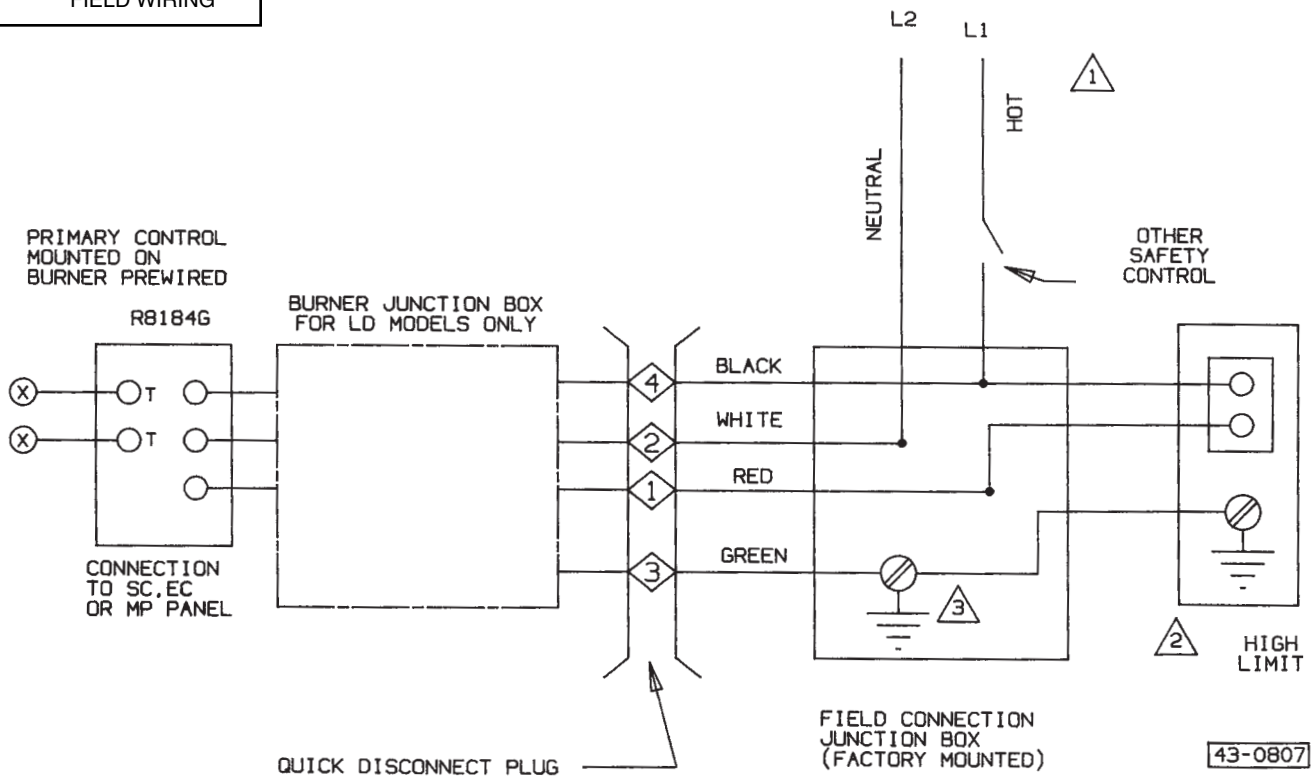


* Install jumper between Terminals 1 and 3 on last low water cutoff only.

** Optional alarm circuit by contractor.

*** For connection see SC2000 or SC1200 wiring diagrams.

LEGEND:
——— FACTORY WIRING
- - - - - FIELD WIRING



1 ELECTRICAL POWER SUPPLY, PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED BY CODES.

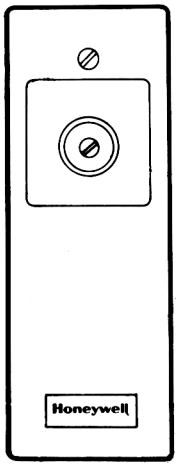
2 CONTROL CASE MUST BE CONNECTED TO EARTH GROUND. USE GROUNDING SCREW PROVIDED.

3 GROUNDING CONDUCTOR: TWO GREEN GROUND WIRES ARE FACTORY CONNECTED TO THE GREEN GROUND SCREW IN THIS BOX. FIELD WIRE A GROUNDED CONDUCTOR TO THIS SCREW TOGETHER WITH THE TWO GREEN FACTORY CONNECTED GREEN GROUND WIRES.

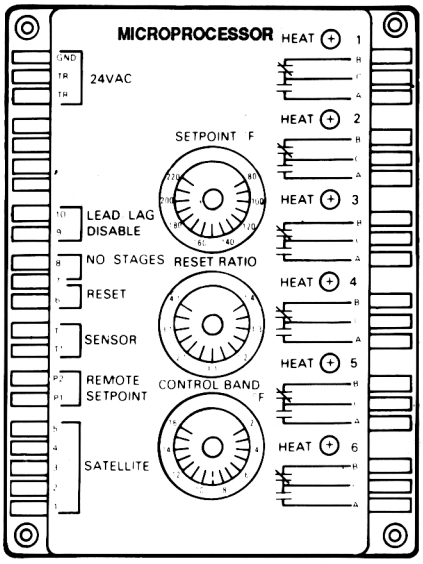
Table C10. Reset Ratio and Temperature Set Points at Desired Water and Outdoor Design Temperatures

Outdoor Design Temperature	Enable T-stat Settings °F	Desired Water Temperature									
		140° F		160° F		180° F		200° F		220° F	
		RR	SP	RR	SP	RR	SP	RR	SP	RR	SP
+20	60	2.5:1	120	1:1	110	1:1.6	100	1:2	100	1:2.4	100
+20	50	1.67:1	110	1:1.1	105	1:1.4	110	1:2.2	90	1:2.4	100
0	60	3.5:1	120	1.4:1	110	1:1	110	1:1.28	110	1:1.56	110
0	50	3.5:1	120	1.27:1	105	1:1.14	100	1:1.42	100	1:1.7	100
-20	60	4.5:1	120	2:1	115	1.28:1	110	1:1	110	1:1.3	105
-20	50	4.5:1	120	2:1	115	1.29:1	110	1:1.11	100	1:1.32	100
-40	60	4.4:1	115	2.44:1	115	1.7:1	115	1.3:1	115	1.04:1	115
-40	50	4.4:1	115	2.2:1	110	1.57:1	110	1.2:1	110	1:1	110

NOTE: RR= Reset Ratio
SP= Set Point



T675A Enable T-stat



W7100J Microprocessor

NOTES:

1. **The starting temperature on the microprocessor control is modified from 40° F to 70° F.** When the outdoor temperature is 70° F or above, boiler water will be maintained at the setpoint temperature. Below 70° F outdoor temperature, boiler water temperature will vary according to the reset ratio setting.
2. This control is factory set to operate 6 stages. To change the number of operating stages, the appropriate resistor must be installed **on the microprocessor control**, across spade terminals 7 and 8. Resistors for 1 through 5 stages are shipped with the SC1200 panels. Resistors for 7 through 10 stages are shipped with the EC1200 panels. See Table C12.
3. The Automatic Lead/Lag function can be disabled by installing a jumper **on the microprocessor control**, across spade terminals 9 and 10.
4. On the SC1200 control panel, a jumper must be field installed **on the microprocessor control**, across spade terminals P12 and P2.

Table C11.
Recommended Control Band Setting

STAGES	CONTROL BAND SETTING
1	16
2	16
3	11
4	8
5	6
6	5
7	5
8	4
9	4
10	2

Table C12.
W7100J Input Resistance for Number of Controlled Stages

STAGES	RESISTORS	
	COLOR	OHMS
1	Blue	100
2	Red	200
3	Yellow	300
4	Brown	400
5	Green	500
6	Gray*	600
7	Orange	700
8	White	800
9	Violet	900
10	Black	1000

*6 stage resistor, factory installed.

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