

# Slant/Fin® Jaguar CARAVAN®

## HOT WATER/GAS MULTIPLE AND CASCADING BOILERS APPLICATION GUIDE

Guidelines for the design, purchase and installation of Slant/Fin Jaguar J-390C Caravan gas-fired, hot water multiple boiler systems.

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### CODES AND STANDARDS

All Caravan installations must comply to local codes or, in the absence of local codes, to the National Fuel Gas Code, ANSI, Z223.1-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. J-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 gas 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.

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.

## 1. INTRODUCTION

If additional information is desired please contact your local Slant/Fin Sales Representative or Slant/Fin Technical Services. Slant/Fin may be found on the web at [www.slantfin.com](http://www.slantfin.com)

This application manual is intended to provide the piping and control method for applying multiple Jaguar J-390C boilers to a space heating and domestic hot water heating system. Use this manual, in conjunction with the Jaguar J-390C Installation and Operating Instructions, publication J-40.

The following sections of the Installation and Operating Instructions (J-390C) must be adhered to:

1. Boiler location and foundation
2. Clearances to combustibles
3. Contamination prevention
4. Air supply and ventilation
5. Venting application and materials\*
6. Water treatment
7. Condensate disposal
8. Operating instructions
9. Care and Maintenance

\*Common venting of these appliances is not permitted. Direct vent terminals cannot be clustered together or stacked vertically. Direct vent terminals can be mounted side by side horizontally, provided there is a 12" minimum distance between them.

There are two methods available to control J-390C Caravan boilers:

1. Jaguar link method to operate up to 8 boilers. An optional system sensor is required for operation of this method. Supply water system sensor (Part no. 833433000) may be ordered to Slant/Fin boiler distributor.
2. External signal (0-10 Vdc input). Control such as Tekmar control 265 or 275 (operates up to 4 boilers). Energy Management System may be used with this method. One optional interface control is required for operation of each boiler in the system. Part number for interface control kit is 830130000.

Jaguar boilers may also be used in a heating system with a Caravan cast iron modular boiler system. Since high efficiency condensing boilers only condense when the return water temperature is low, around 130 F or lower, it makes sense to use a lower cost Caravan cast iron boiler at higher water temperature. We call a combination Caravan Cast Iron Modular Boiler used in a system with a Jaguar Multiple Boiler a "Hybrid Boiler System". We address Hybrid Boiler Systems within this manual.

## 2. RATINGS AND DIMENSIONS

Table 1: Gas multiple boiler ratings and dimension/hot water model 50 psi maximum working pressure

Model No.	Consists of		CSA Input (MBH)		CSA output (MBH)		I=B=R Net (MBH)		Combustion Efficiency		Boiler Horse-Power
	No. of Htg. Boiler	Boiler Model No.	Max	Min	Max	Min	Max	Min	Max	Min	
J-390C 2B	2	J-390C	780	110	704	106	612	92	91.6	96.7	21
J-390C 3B	3	J-390C	1170	110	1056	106	918	92	91.6	96.7	31.5
J-390C 4B	4	J-390C	1560	110	1408	106	1224	92	91.6	96.7	42
J-390C 5B	5	J-390C	1950	110	1760	106	1530	92	91.6	96.7	52.6
J-390C 6B	6	J-390C	2340	110	2112	106	1836	92	91.6	96.7	63.1
J-390C 7B	7	J-390C	2730	110	2464	106	2142	92	91.6	96.7	73.6
J-390C 8B	8	J-390C	3120	110	2816	106	2448	92	91.6	96.7	84.1

Model No.	Water Content (gal.)	Ship Wt. Lbs.	Vent Conn	Air Intake.	Water Correction at Boiler	Space Btwn. Boilers	** Length with Header	** Min. Header Size
J-390C 2B	4	600	4"	4"	1-1/4	3-1/4	50-1/2"	2"
J-390C 3B	6	900	4"	4"	1-1/4	3-1/4	77-3/4"	2"
J-390C 4B	8	1200	4"	4"	1-1/4	3-1/4	104-1/4"	3"
J-390C 5B	10	1500	4"	4"	1-1/4	3-1/4	131-1/8"	3"
J-390C 6B	12	2340	4"	4"	1-1/4	3-1/4	158"	3"
J-390C 7B	14	2730	4"	4"	1-1/4	3-1/4	184-7/8"	3"
J-390C 8B	16	3120	4"	4"	1-1/4	3-1/4	211-3/4"	3"

System Turndown	
Model No.	Turndown Ratio
J-390C 2B	7 to 1
J-390C 3B	10.6 to 1
J-390C 4B	14.2 to 1
J-390C 5B	17.7 to 1
J-390C 6B	21.3 to 1
J-390C 7B	24.8 to 1
J-390C 8B	28.4 to 1

\*\* "Length with headers allows for 3 1/4" between boiler.

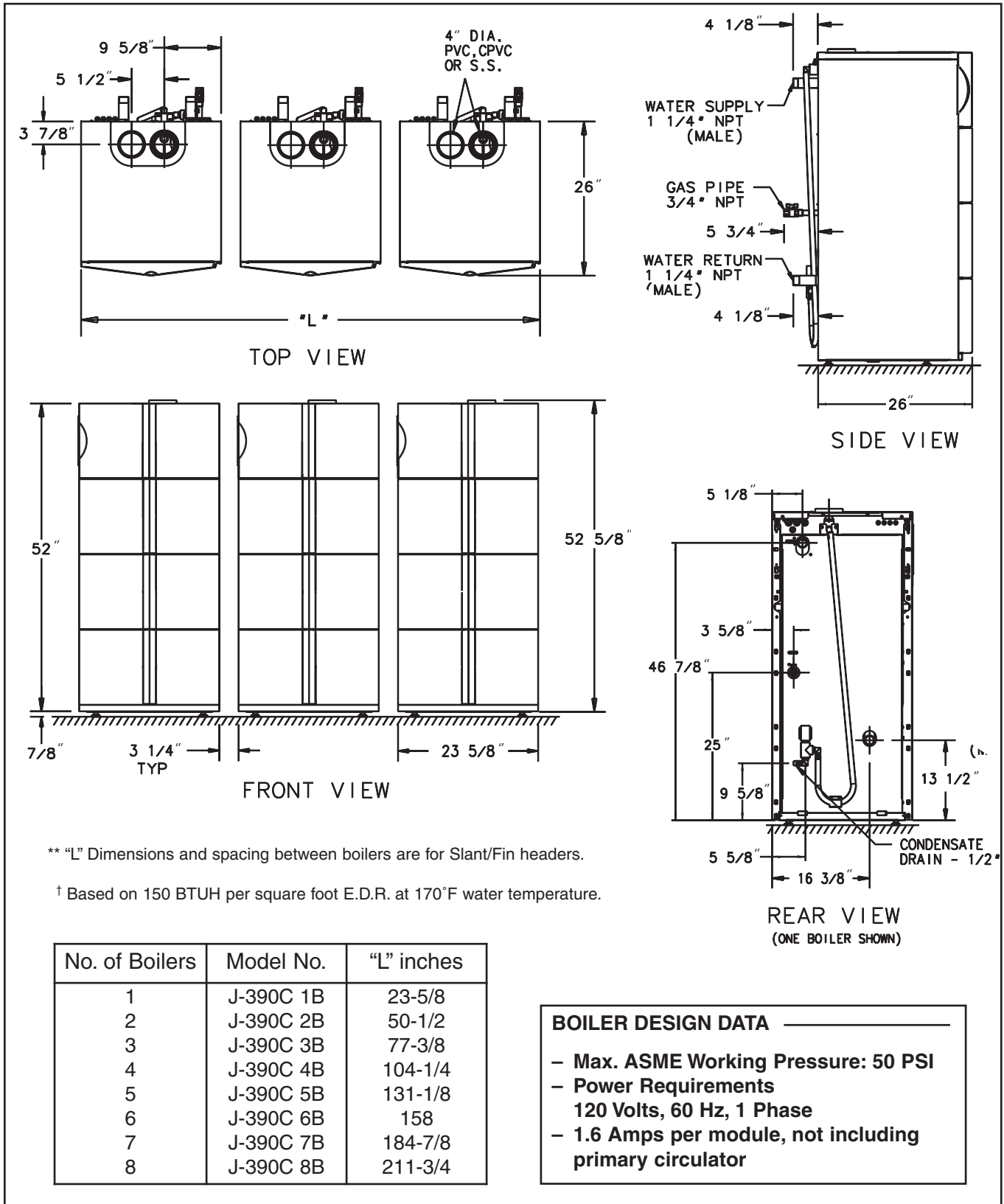


Figure 1. Dimensions

**3. BOILER ROOM DESIGN AND LAYOUT**

Jaguar Caravan Multiple Boilers allow better utilization of floor space and permit future boiler system expansion with minimum cost. Jaguar boilers are hand truckable, fit through doorways and can often be installed around existing boilers. Boilers can be installed in line, back to back, at angles or in multiple rows. Layout is flexible. Figure 2 gives a typical layout using Slant/Fin Headers.

Boiler rooms and enclosures should comply with local code requirements. Provide a level and solid foundation for the boilers. Equipment pads should be capable of supporting the boilers filled with water and extend past the boiler jackets by at least 2 inches. Jaguar boilers are approved for installation on combustible and non-combustible floors, however Jaguar boilers must not be installed on or above carpeting. All boiler components should be protected from water during installation, set up, operation and service.

Minimum clearances to combustible materials should comply with local code requirements. Slant/Fin minimum clearances are listed below.

**MINIMUM CLEARANCES FROM COMBUSTIBLE CONSTRUCTIONS**

A. Minimum clearances to the exterior surfaces of the boiler shall be as follows:

**MINIMUM ALCOVE AND CLOSET CLEARANCE**

<u>Surface</u>	<u>For Combustible Construction</u>	<u>Recommended for Service</u>
Front	0"	24"
Rear	0"	8"
Left Side	0"	0"
Right Side	0"	0"
Top	4"	6"
Flue Connector:		
Enclosed —	2"	6"
Uninclosed —	1"	6"

- B. Provide accessibility clearance of 8" on sides requiring servicing and 18" on sides used for passage.
- C. All minimum clearances shown above must be met. This may result in increased values of some minimum clearances in order to maintain the minimum clearances of others.
- D. Clearance from hot water pipes shall be 1 inch\*\*.

\*\* At points where hot water pipes emerge from a floor, wall or ceiling, the clearance at the opening through the finished floor boards or wall or ceiling boards may be not less than 1/2 inch. Each such opening shall be covered with a plate of uncombustible material.

**SAFETY**

KEEP THE BOILER AREA CLEAR AND FREE FROM COMBUSTIBLE MATERIALS, GASOLINE AND OTHER FLAMMABLE VAPORS AND LIQUIDS.

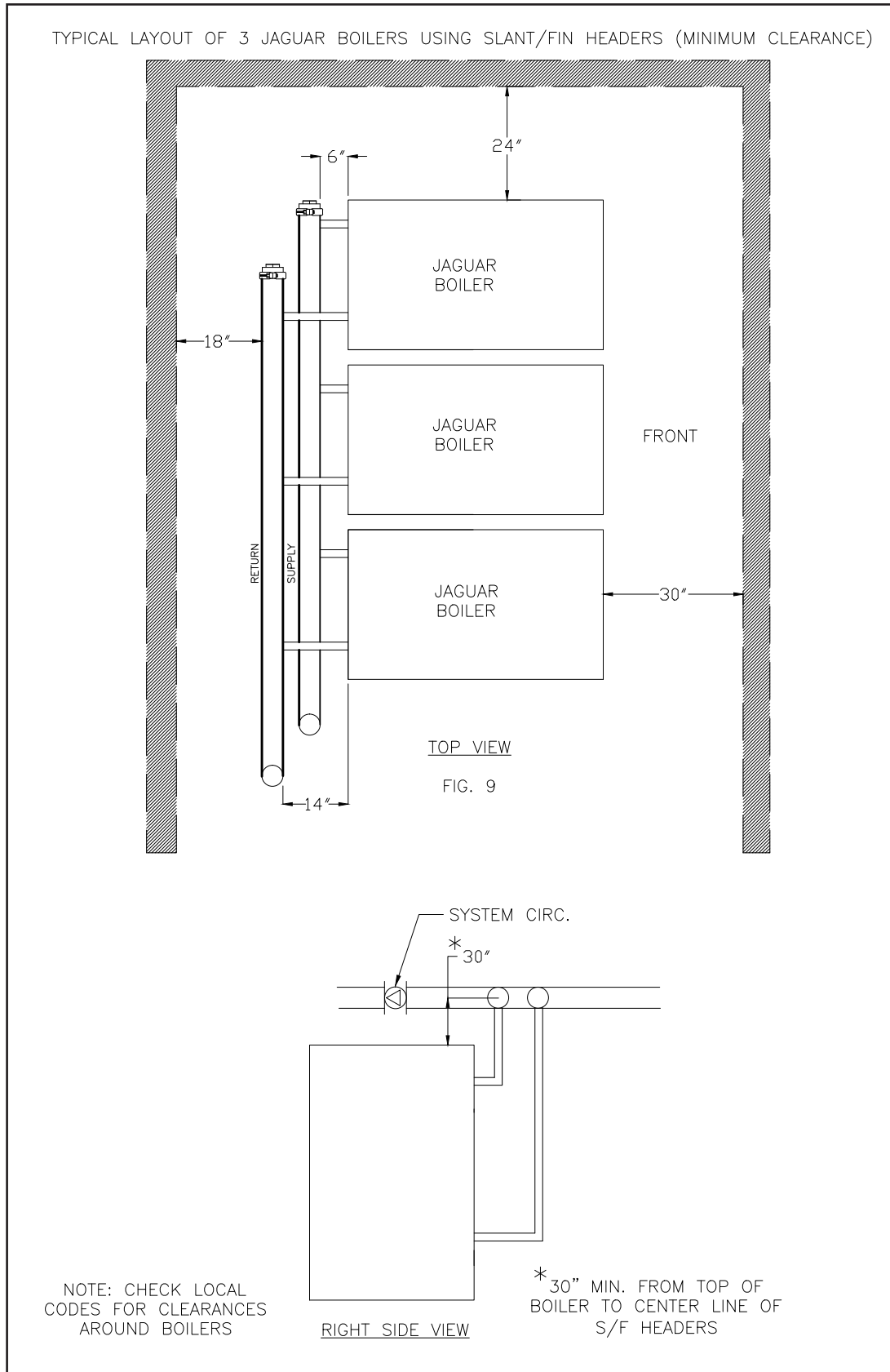


Figure 2. Typical layout of 3 Jaguar Boilers using Slant/Fin Headers (Minimum Clearance)

#### 4. FRESH AIR AND CONTAMINATION PREVENTION

The combustion air supply must not be susceptible to contamination sources, whether the combustion air comes from the interior or exterior of the building. Contaminated air can cause corrosion or other damage to the heat exchanger and components of the boiler, causing failure of these parts or unsafe operation.

Below is a list of products and areas which may cause contaminated combustion air:

##### PRODUCTS TO AVOID

- Spray cans containing chloro/fluorocarbons
- Permanent wave solutions
- Chlorinated waxes/cleaners
- Chlorine-based swimming pool chemicals
- Calcium chloride used for thawing
- Sodium chloride used for water softening
- Refrigerant leaks
- Paint or varnish removers
- Hydrochloric acid/muriatic acid
- Cements and glues
- Antistatic fabric softeners used in clothes dryers
- Chlorine-type bleaches, detergents, and cleaning solvents found in household laundry rooms
- Adhesives used to fasten building products and other similar products

##### AREAS LIKELY TO HAVE CONTAMINANTS

- Dry cleaning/laundry areas and establishments
- Swimming pools
- Metal fabrication plants
- Beauty shops
- Refrigeration repair shops
- Photo processing plants
- Auto body shops
- Plastic manufacturing plants
- Furniture refinishing areas and establishments
- New building construction
- Remodeling areas
- Garages with workshops

#### 5. BOILER ROOM AIR SUPPLY AND VENTILATION

An ample supply of air is required for combustion and ventilation. When buildings are insulated, caulked and weather-stripped, now or later on, direct openings to outside may be required and should be provided. If the boiler is not near an outside wall, air may be ducted to it from outside wall openings.

Provisions for combustion and ventilation air must be made in accordance with section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas Code, ANSI Z223.1-latest edition, or applicable provisions of the local building codes. The following recommendation applies to buildings of energy-saving construction, fully caulked and weatherstripped.

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

##### A. NON-DIRECT VENT INSTALLATION

1. **Air drawn horizontally from outdoors DIRECTLY through an outside wall;** one louvered opening near the floor and one louvered opening near the ceiling, each opening with a minimum FREE air passage area of **1 square inch per 4000 Btuh** of total appliances' input.
2. **Air drawn horizontally through HORIZONTAL DUCTS;** one opening near the floor and one opening near the ceiling, each opening with a minimum FREE air passage area of **1 square inch per 2000 Btuh** of total appliances' 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 appliances' input.
4. **Air drawn from inside the building;** one opening near the floor and one opening near the ceiling, each opening with a minimum FREE air passage area of **1 square inch per 1000 Btuh** of total appliances' 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.

##### B. DIRECT VENT INSTALLATION

Adequate air supply should be provided to prevent overheating of the boiler controls and boiler room. Openings for passage of air into the boiler room for direct-vent installation must be at least  $\frac{1}{2}$  of the openings required for the non-direct vent as mentioned above.

If additional non-direct vent appliances are installed in the same space and adequate air openings are provided for them, there are no additional air openings required for the Jaguar J-390C boiler.

For both direct and non-direct installation, the following must be considered:

- Openings must never be reduced or closed. If doors or windows are used for air supply, they must be locked open.
- Protect against closure of openings by snow and debris. Inspect frequently.
- No mechanical draft exhaust or supply fans are to be used in or near the boiler area.
- Boiler area must never be under negative pressure. The flow of combustion and ventilating air to the boiler must not be obstructed.



**6. VENTING REQUIREMENTS**

The Jaguar J-390C is a sealed combustion type boiler, it may be installed and vented either as a direct vent boiler which all air for combustion is obtained directly from outside or as a non-direct vent boiler which air for combustion is taken from inside the boiler room.

The Jaguar J-390C boiler must be vented by 4" diameter PVC/CPVC schedule 40 pipe, or the proper 4" diameter stainless steel venting system (see "vent material" on this page) through the roof or sidewall.

**FLUE GAS VENTING REQUIREMENTS**

The Jaguar J-390C series boiler is a high efficiency, mechanically forced draft boiler and, therefore, require different venting arrangements than natural draft, lower efficiency boilers.

**THE FOLLOWING INSTRUCTIONS MUST BE CAREFULLY READ AND FOLLOWED IN ORDER TO AVOID ANY HAZARDOUS CONDITIONS DUE TO IMPROPER INSTALLATION OF THE AIR INTAKE AND FLUE GAS VENTING SYSTEM.**

The vent piping installation **MUST** be in accordance with these instructions and with ANSI Z223.1-latest edition NATIONAL FUEL GAS CODE, Part 7, Venting of Equipment. Other local codes may also apply and must be followed. Where there is a conflict between these requirements, the more stringent case shall apply.

The use of a vent damper is **NOT** permitted on this boiler series.

**ADDITIONAL REQUIREMENTS FOR THE COMMONWEALTH OF MASSACHUSETTS**

When the Jaguar is installed and used in the Commonwealth of Massachusetts, the following additional requirements pursuant to Massachusetts code 248 CMR **MUST** be met:

(1). Existing chimneys shall be permitted to have their use continued when a gas conversion burner is installed, and shall be equipped with a manual reset device that will automatically shut off gas to the burner in the event of a sustained back-draft.

(2)(a). For all side wall horizontally vented gas fuel equipment installed in every dwelling, building or structure used in whole or part for residential purposes, including those owned or operated by the Commonwealth and where the side wall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. **INSTALLATION OF CARBON MONOXIDE DETECTORS.** At the time of installation of the side wall horizontal vented fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors.

a. In the event that the side wall horizontally vented gas fuel equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back up may be installed on the next adjacent floor level.

b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

2. **APPROVED CARBON MONOXIDE DETECTORS.** Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. **SIGNAGE.** A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally vented gas fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, **"GAS VENT DIRECTLY BELOW, KEEP CLEAR OF ALL OBSTRUCTIONS"**.

4. **INSPECTION.** The state or local gas inspector of the side wall horizontally vented gas fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

(b) **EXEMPTIONS.** The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:

1. The equipment listed in Chapter 10 entitled "Equipment Not Required TO Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
2. Product Approved side wall horizontally vented gas fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or part for residential purposes.

**VENT AND AIR INTAKE MATERIALS**

The vent and air intake system for direct or non-direct vent installation must be 4" diameter PVC/CPVC schedule 40 pipe, or UL listed single wall 4" diameter AL29-4C\* stainless steel material. The following manufacturers' systems are approved for use within a specified minimum and maximum equivalent vent length in this manual.

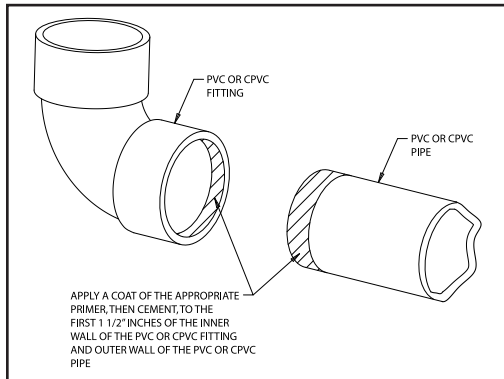
Manufacturer	Type/System	Sealant
Heat-Fab, Inc.	Saf-T Vent EZ Seal	Not Required
ProTech System, Inc.	FasNSeal	Not Required
Flex-L International Inc.	StaR-34	GE-IS806
Metal-Fab, Inc.	Corr Guard	Not Required
N/A	PVC pipe, Schedule 40	PVC primer and cement
N/A	CPVC pipe, Schedule 40	CPVC primer and cement

When joining the various components of the listed stainless steel vent systems, the manufacturers' instructions should be closely followed to insure proper sealing. Use sealant specified by vent system manufacturer for sealing of pipe and fittings, if required. When joining the PVC/CPVC pipe and fittings, follow the instructions provided in this manual. All connections must be liquid and pressure tight. **DO NOT** use galvanized flue pipe or any plastic-type materials other than PVC/CPVC Schedule 40.

- \* Maximum exhaust vent length = 100 feet
- \* Maximum air intake length = 100 feet
- \* Each elbow is equivalent to 10 feet of straight pipe

## VENT AND AIR INTAKE RESTRICTIONS

1. Maximum allowed equivalent vent and air intake length for all of the approved vent and air intake materials is 100 equivalent feet.
2. Equivalent of vent or air intake length is sum of the straight pipe lengths and equivalent length of elbows. Each 90° elbow is equivalent to 10 ft. of 4" pipe.



**Figure 3.**

3. The vent termination is in addition to the allowed equivalent lengths.
4. Minimum vent length is 2 feet of straight pipe, plus one 90° elbow.
5. Vent length restriction is for both direct and non-direct vent installations.

**EXAMPLE:** The combustion air is provided by air intake piping directly to the boiler (direct-vent installation). The vent piping will be PVC and installation location will require the use of 4 elbows for the vent to run the termination. The air intake piping will also be PVC, and also will require the use of 4 elbows.

In this case, the maximum straight pipe vent length that can be utilized with the 4 elbows would be:  $100' - (4' \times 10') = 60'$ . Since the air intake pipe also is PVC and requires the use of 4 elbows, the maximum straight pipe air intake length that can be utilized is also 60 feet.

If the air for combustion were taken from the boiler room (non-direct vent installation), still the maximum straight vent length would be 60 feet.

6. The Jaguar J-390C boiler is equipped with a built-in condensation drain and trap system. The traps must be filled with water. DO NOT operate the boiler without filling the trap with water to prevent flue gas discharge into space. The drain must dispose of possibly large quantities of condensate, which may require a neutralizing system. Refer to the "Condensate Drainage" section of this manual. No additional condensation drain and trap is required on the vent piping system itself.
7. The horizontal vent pipe must be sloped upward from the boiler at a pitch of at least 1/4" per 1 foot of run, so that the condensate from the vent system runs to the boiler vent adapter pipe, then out the built-in condensation drain and trap.
8. The horizontal vent and air intake pipes must be supported with pipe straps, at intervals no greater than 5 feet, when PVC/CPVC pipe is utilized. This support spacing applies also to stainless steel vent pipe, unless the manufacturer's instructions permit otherwise. The vertical vent and air intake pipes also must be supported, wherever the building construction provides allowance for it, such as ceiling or roof passage openings where a firestop and support or braces can be affixed.
9. Minimum clearances of vent pipes from combustible constructions must be maintained (Pub J-40). No clearance is required between the vent and air intake pipes of this boiler.
10. Common venting with other appliances or another Jaguar boiler is not allowed.
11. DO NOT install a vent damper or similar devices in vent system or on the boiler.
12. DO NOT insulate venting system.

## VENTING INSTALLATION

Only PVC/CPVC and approved stainless steel materials listed on page 7 may be used for the venting system installation. If stainless steel vent systems are used, follow the manufacturer's instructions, in conjunction with these instructions.

### I. Non-Direct Vent Installation

The air for combustion is taken from the ambient air surrounding the boiler; therefore, ample supply of air is required for combustion and ventilation (see page 6.)

DO NOT use this installation method if the surrounding of the boiler is contaminated. See page 6 for the list of harmful contaminants and their sources, to avoid.

**CAUTION:** Flue gasses exiting from the vent terminal will condense. Building materials in the area of the vent terminal should be protected from discoloration and degradation.

### VENT TERMINATION LOCATION AND CLEARANCES

1. The venting system shall terminate at least 3 feet above any forced air inlet located within 10 feet.
2. The venting system shall terminate at least 12 inches below, or 12 inches horizontally from any door, window or gravity air inlet into any building. The bottom of the vent terminal or air intake terminal shall be at least 12 inches above grade or the normal snow level whichever is greater.
3. Through the wall vents shall not terminate over public walkways or over areas where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves or other equipment. Minimum clearance of 4 feet horizontal distance is maintained, from electric meters, gas meters, regulators and relief equipment.
4. Vent termination must not be located in any confined space (i.e. window wells, alcoves, narrow alleys) or under any over hang or deck. Vent termination should not allow flue gas discharge towards neighbor's windows or where personal injury or property damages can occur.

### A. NON-DIRECT VENT - VERTICAL VENTING

Figure shows typical venting through the roof. The vent pipe must pass through the ceiling, floor and the roof vertically through a 8" minimum diameter cutout. A fire stop is required for each ceiling and floor penetration. For roof passage, an appropriate UL listed roof flashing must be used.

An existing chimney may be used as a chase for vertical venting. Other appliances CANNOT be vented into the same chimney or vent pipe with in the chimney.

The vertical vent piping must terminate with a screened tee, combination of 45° elbow and a 90° screened elbow termination or a rain cap termination.

### II. Direct Vent Installation

Air intake piping from outside to the boiler air intake adapter provides the air for combustion. The boiler surrounding may be contaminated (See page 6). Piping the air intake to the outside can prevent contaminants from the boiler surrounding from entering the combustion air supply.

### B. SIDEWALL DIRECT VENTING

Vent termination location and clearances for non-direct vent stated in paragraph I, also applies to sidewall direct venting.

- See figure 4, 5 & 6 for direct vent side wall venting using the Slant/Fin vent/air intake termination.
- See figure 6 for direct vent side wall venting with close spacing.
- See figure 7 & 8 for direct vent through the roof.

**CAUTION:** Flue gasses existing from the vent terminal will condense. Building materials in the area of the terminal should be protected from discoloration and degradation.



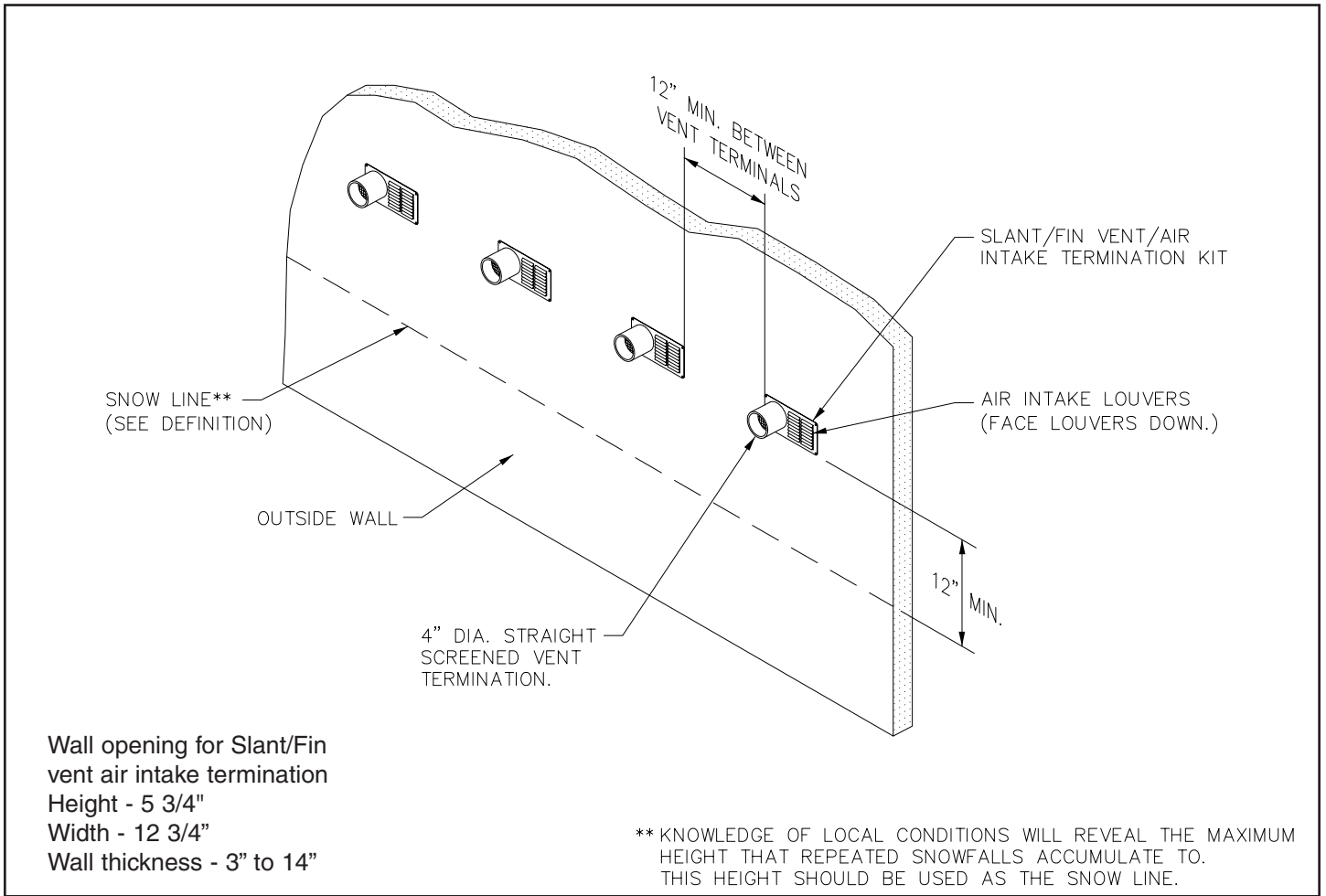


Figure 4.

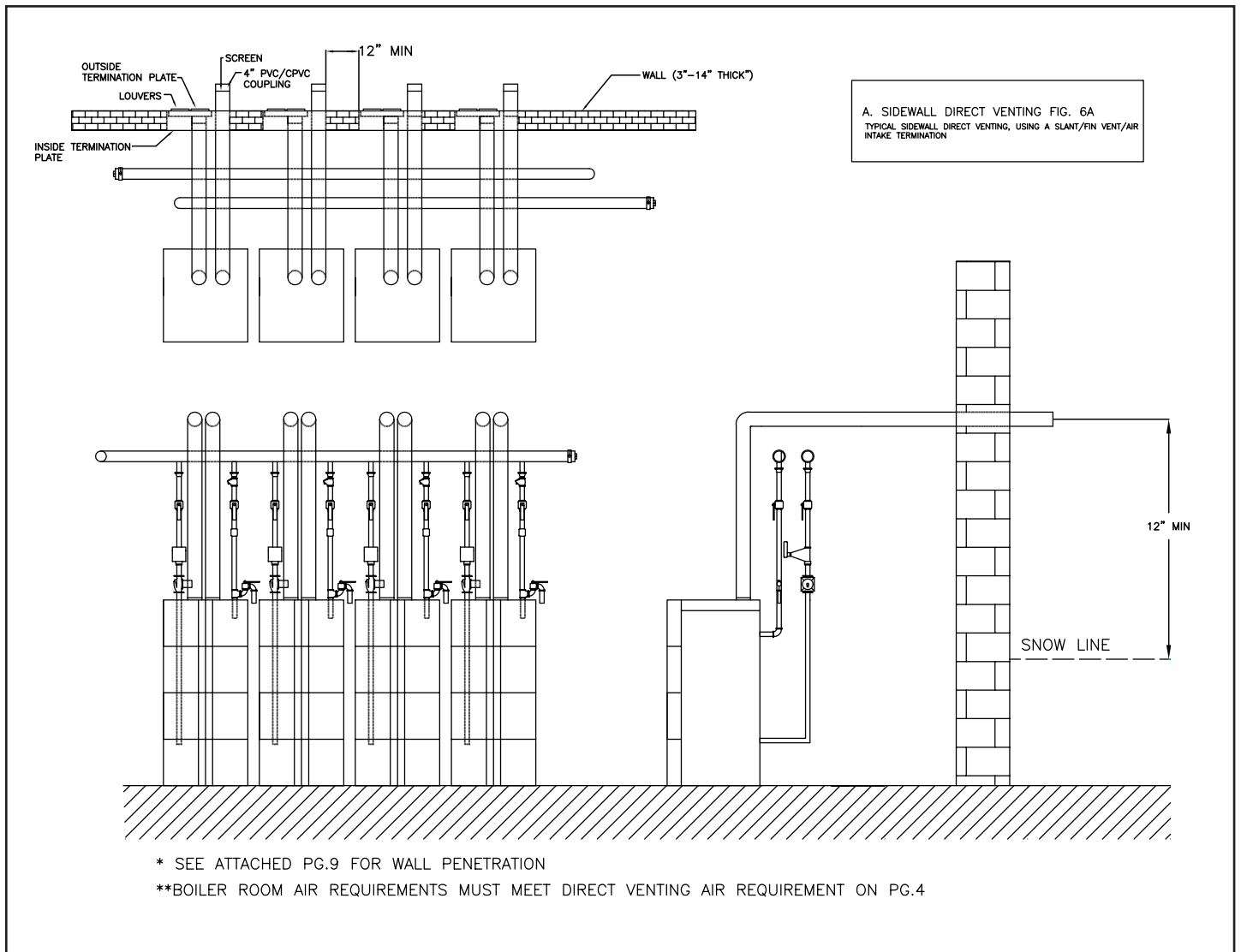
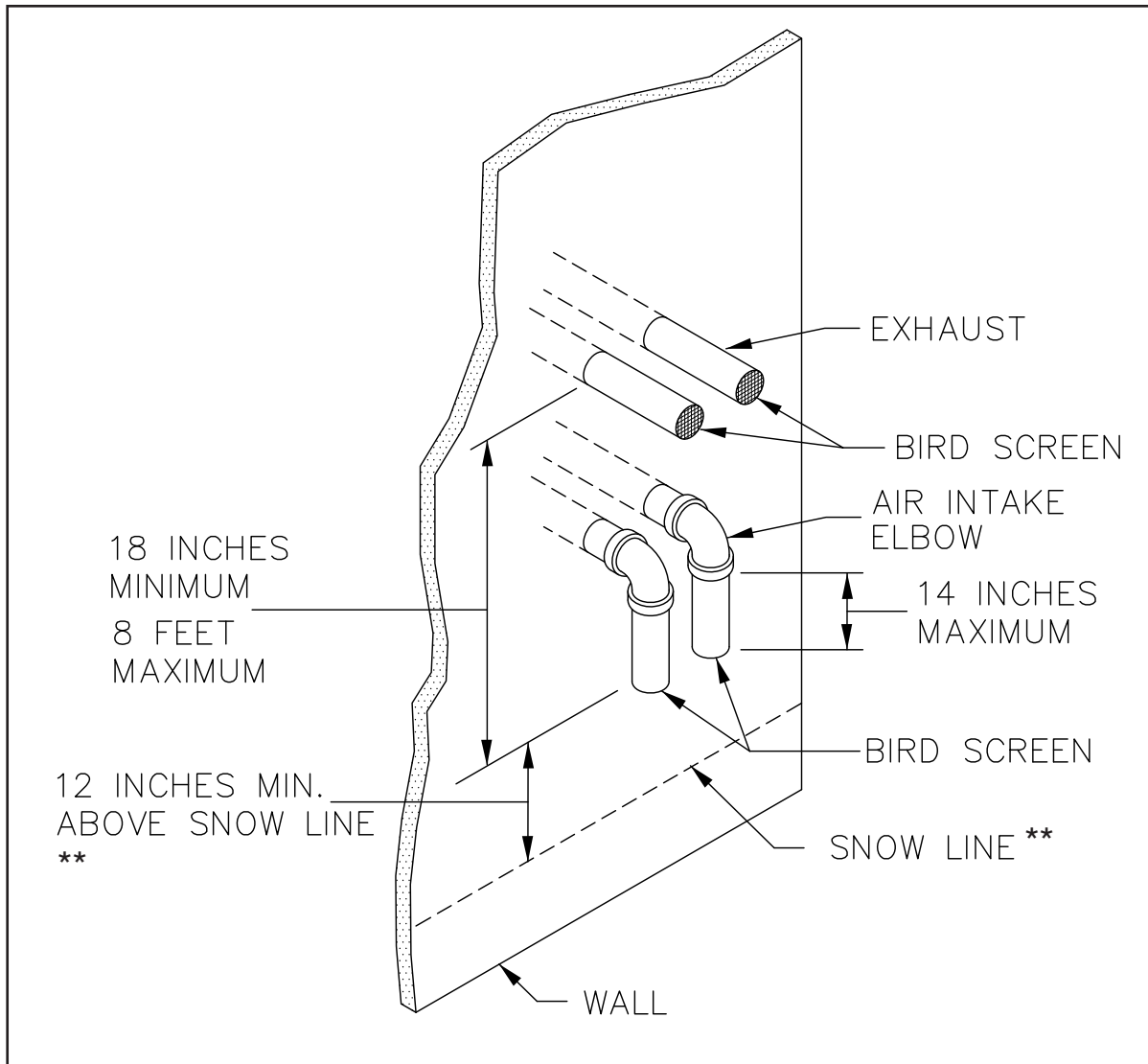


Figure 5.



**Figure 6. Alternative multiple side wall air intake & exhaust venting.**

**Note:**

- **Air intake opening must be 12 inches minimum above snow line or grade if it does not snow in area boilers are located.**
- **No minimum horizontal distance between outlets or inlets.**
- **Exhaust termination to extend beyond air intake, prevent condensation from falling onto air intake**

**\*\* Knowledge of local conditions will reveal the maximum height that repeated snowfalls accumulate to. This height should be used as the snow line.**

NON-DIRECT VENT-VERTICAL VENTING

Figure 7 shows typical venting through the roof. The vent pipe must pass through the ceiling, floor and the roof vertically through a 8" minimum diameter cutout. A fire stop is required for each ceiling and floor penetration. For roof passage, an appropriate UL listed roof flashing must be used.

An existing chimney may be used as a chase for vertical venting. Other appliances CANNOT be vented into the same chimney or vent pipe with in the chimney.

The vertical vent piping must terminate with a screened tee, combination of 45° elbow and a 90° screened elbow termination or a rain cap termination.

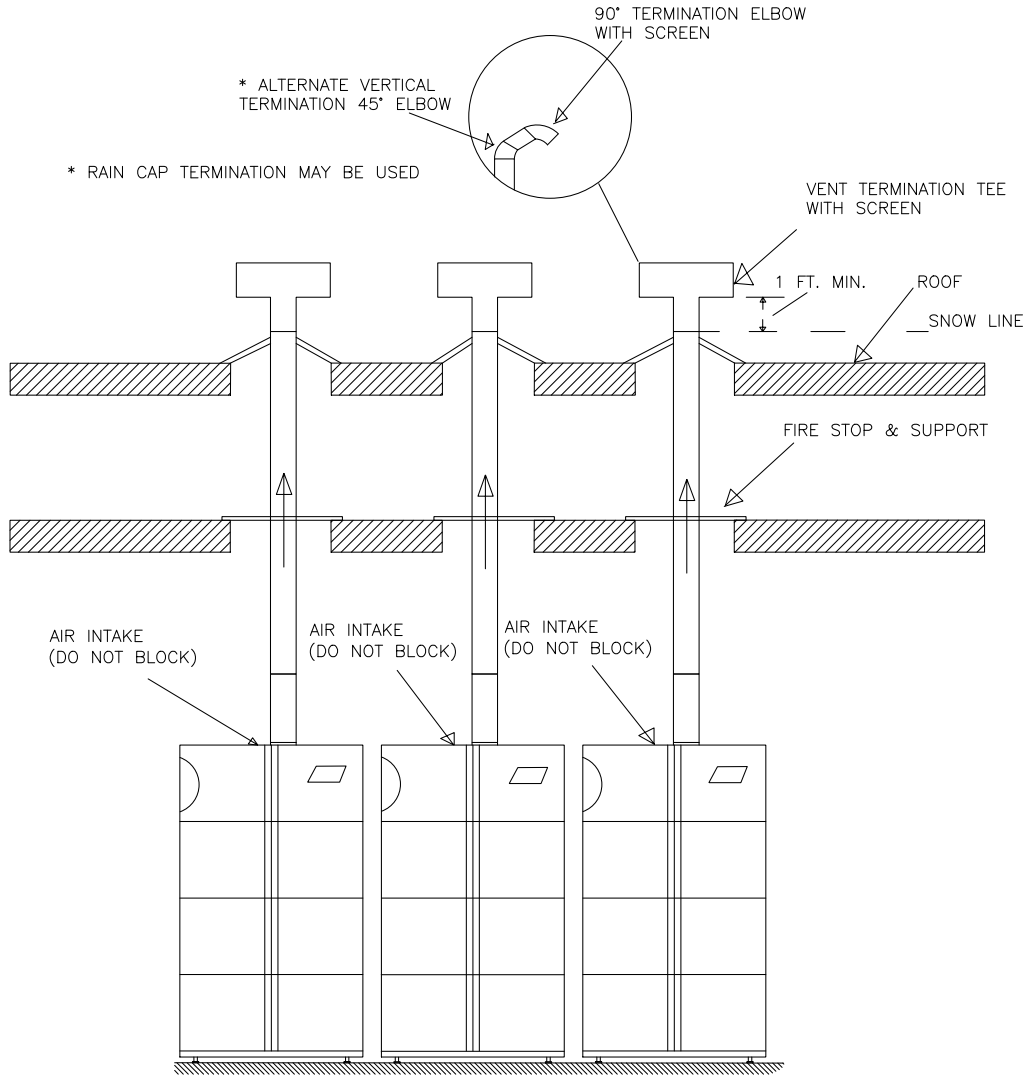
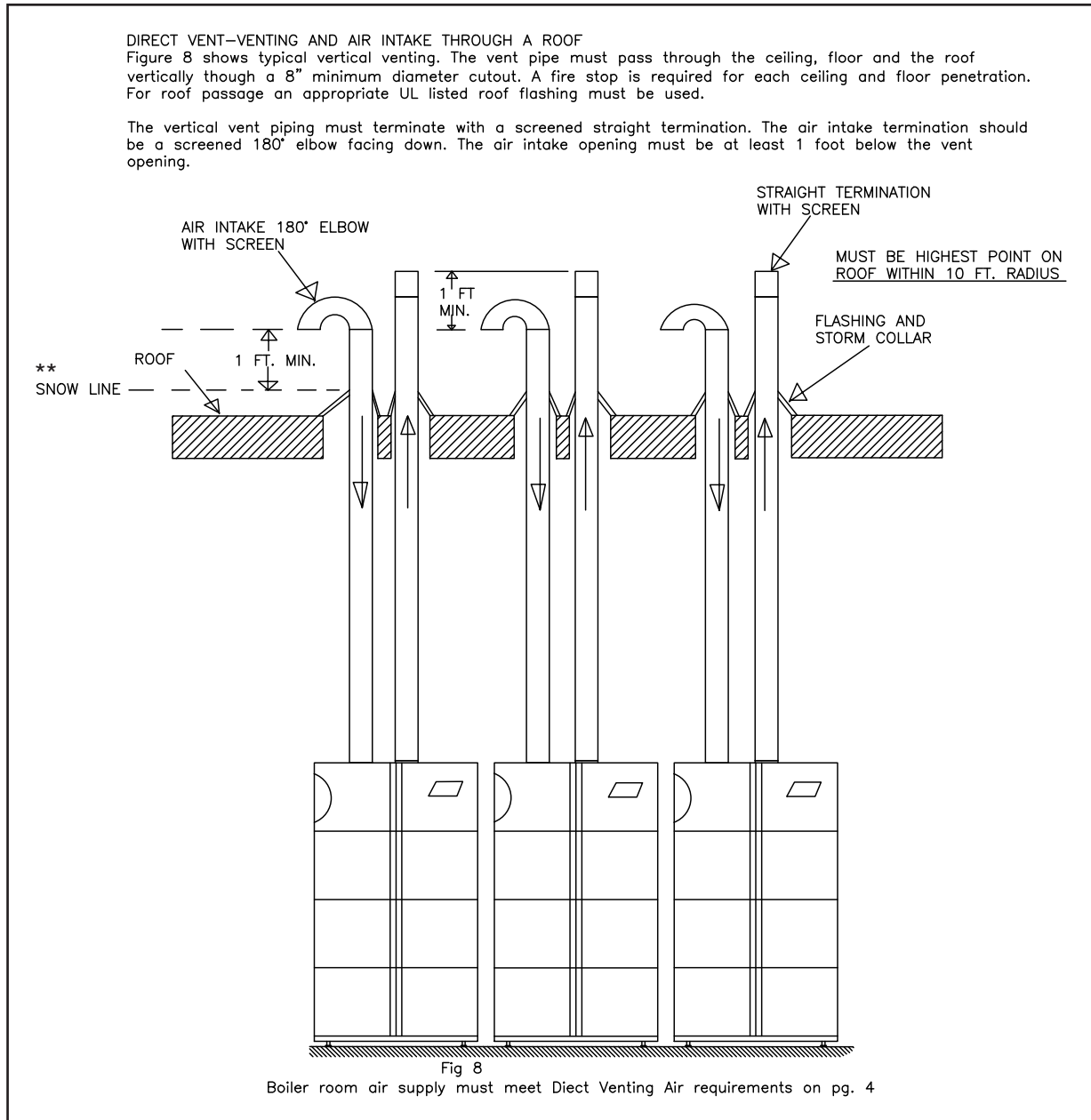


FIG 7 VERTICAL VENTING

Boiler room air requirements must meet Non-direct Vent air requirements on pg. 4

Figure 7.



**Figure 8. Direct Venting and Air Intake Through a Roof.**

**\*\* Knowledge of local conditions will reveal the maximum height that repeated snowfalls accumulate to. This height should be used as the snow line.**

**7. CONDENSATE REMOVAL SYSTEM**

The Jaguar J-390C boiler is equipped with a built-in condensation drain and trap system. This system consists of two traps, one being dedicated to the condensate produced by the boiler, and another being dedicated to the condensate produced within the vent piping. Both of these traps must be filled with water. This is most easily accomplished by pouring water from a small container into the vent connector at the top of the boiler, before the vent pipe is attached, until the tubing loop trap in the rear of the boiler is visibly filled. DO NOT operate the boiler without filling the trap with water to prevent flue gas discharge into space. Periodic inspection should be made of this assembly for deterioration of the tubing and components, and to insure that the traps are not plugged. If any part is plugged or appears to have excessive sediment within, it should be removed from the drain assembly, have the obstruction cleared, refilled with water and reinstalled as before.

A 3/4" PVC tee assembly, located in the rear of the boiler jacket, is provided to run the condensate liquid from the boiler. Connect the plastic tubing that will be run to the drain to the bottom take-off of the tee. Leave the top take-off of the tee open, to act as a vacuum breaker. If the building drain is above the bottom portion of the tee, a condensate removal pump will be required. This pump must have an overflow switch, and be compatible with the acidic condensate liquid, as must all fittings and the tubing used in this condensate removal system. (See Figure 9).

No part of the condensate removal system can be exposed to freezing temperatures, or any other conditions that could cause blockage. DO NOT run drain tubing to the outside of the building. In addition, certain jurisdictions or drain pipe materials may require a neutralization unit to be installed in the condensate removal system. Any piping other than plastic types will be subject to corrosion or deterioration from the acidic condensate, which may have a pH level as low as 3.0. A condensate filter containing lime, marble, or phosphate chips can neutralize the condensate to a pH level above 6.5, which is safe for all drain piping materials. (See Figure 9). The neutralizing filter medium will require periodic changing, to ensure it's affectiveness. Replacing the medium on an annual basis is recommended, or refer to the manufacturer's instructions for systems that are available for neutralizing condensate.

**COMMONWEALTH OF MASSACHUSETTS SPECIAL REQUIREMENT**

When the Jaguar J-390C is installed and used in the Commonwealth of Massachusetts, a neutralization unit MUST be installed in the condensate removal system.

**8. WATER PIPING AND**

Jaguar Multiple Boiler Systems utilize primary/secondary piping. Jaguar boilers require a minimum of 17.5 gallons per minute water flow rate. A primary loop circulator is factory supplied with each Jaguar boiler, this circulator should be used in the boilers primary loop. Listed below is a chart listing the Jaguar boiler's pressure drop based on GPM flow rate, this chart also lists water temperature rise based on maximum gas input.

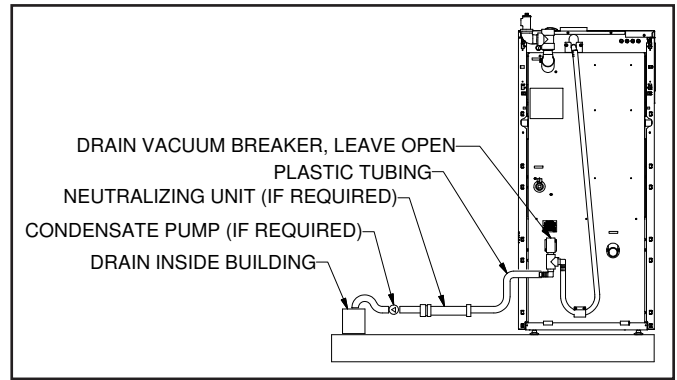


Figure 9. Condensate disposal system

**PIPING AND WATER FLOW**

Good system design addresses flow rates through boilers. It is possible to have too little flow and too much flow. Most boiler system designs are based on a 20°F to 30°F temperature rise in the boiler when it is firing at full input.

When the flow rate is too high through a module the water flow tends to short circuit from the return tapping to the supply tapping of a module. When flow rate is too high the boiler efficiency may drop and there is excess electrical consumption by the circulator. Primary/secondary piping is required for multiple Jaguar boilers. This method ensures that each boiler will receive the same inlet water temperature, and only the boilers that are firing will have water flowing through them. Each boiler must have a dedicated circulator piped on it's primary loop. See figures 10 and 11 for the location of components and piping layout.

If isolation valves are installed in the individual boiler piping to the common headers, a dedicated manual reset low water cutoff and manual reset high limit must be installed on each boiler's piping, as close to the boiler as possible and beneath the isolation valves. See figures 10 and 11.

The primary loop must have its own pump, water that is flowing in the primary loop will not flow into the secondary circuit

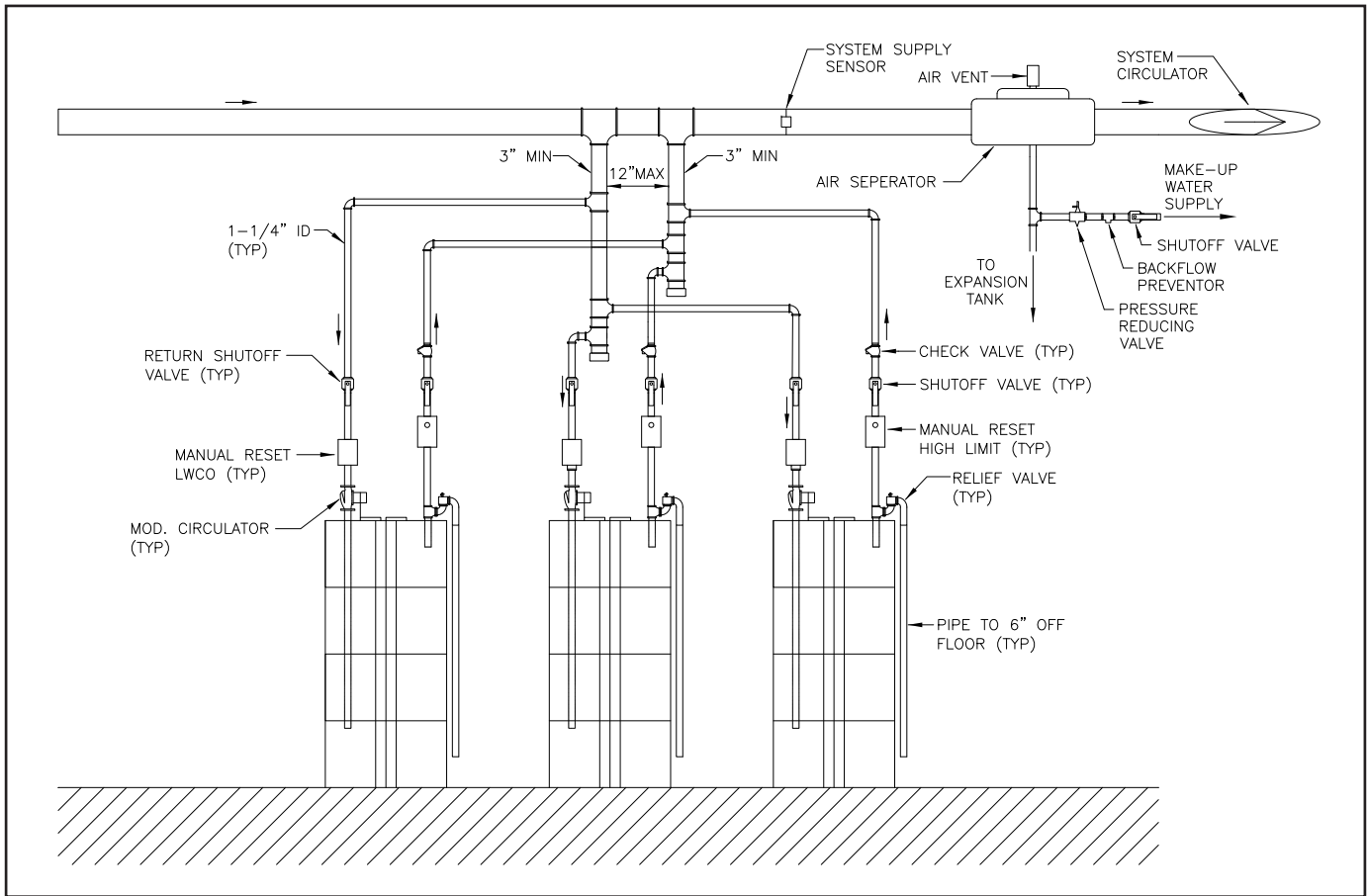
**Boiler Pressure Drop**

Flow Rate (gpm)	Temp Rise (°F)	Boiler Head Loss (Feet w.c.)
28.0	25°	16
23.5	30°	11.5
20.0	35°	8.5
17.5*	40°	7.0

Jaguar Multiple Boiler System may be piped using Slant/Fin supplied headers or by using field piped primary boiler loops.

\* Minimum flow rate recommended.





**Figure 10. shows typical field piped primary loops for Jaguar Multiple boiler systems. Each Jaguar boiler shall be installed with a manual reset Hi Limit and a Manual Reset Low Water Cutoff being located on the boiler side of any shut off valves and check valves.**



**9. GAS LINE SIZING AND LAYOUT**

**GAS PIPING**

This section contains sizing and construction recommendations for fuel supply piping to Caravan gas-fired modular boiler systems. Gas-fired equipment must conform not only to codes of local regulatory agencies, but also to additional specifications that may be imposed by the utility or gas supplier. Therefore, the following information should be considered only as a guideline.

Figure 6 illustrates a typical gas supply line installation. It consists of a main between the utility’s meter box and the boiler system, a main shut-off valve sediment trap, gas header pipe and drip legs on individual boilers.

Individual gas lines to individual boiler modules should be equal to or greater than the boilers supplied gas connection diameter. Size of gas main and header pipes depends on volume of gas required and acceptable pressure drop between meter and modules gas regulator valves. Minimum pressure required at each valve is 3 inches of water column for natural gas measured while all boilers and other gas-fired equipment on the same meter are firing. Final pressure of gas header must vary no more than +0.3 in. of water column.

Number of boilers	Cubic feet per hour
2	780
3	1170
4	1560
5	1950
6	2340
7	2730
8	3120

**Table 1. Gas consumption rate.**

**Gas main sizing**

To determine the correct pipe diameter for the gas main serving a specific Caravan system, proceed as follows:

- a. Follow the building plans, find total length of straight pipe between supply from gas meter and boiler gas header.
- b. Using data in Table 2, calculate equivalent linear length of screw pipe fittings used in fabrications of main. Add this to figure from step (a) to obtain equivalent total length.
- c. Find Caravan gas consumption in cubic feet per hour from Table 1.
- d. Multiply the system total hourly gas consumption by flow correction value from local utility. If not available, use 1000 btu/cu.ft. (correction value = 1)
- e. Locate system’s total equivalent pipe length in Table 3.
- f. Move vertically to the system’s corrected flow rate calculated in step (c). If this value falls between two of those listed, selected larger value.
- g. From this point move horizontally to the left column and read suggested pipe diameter for gas main.

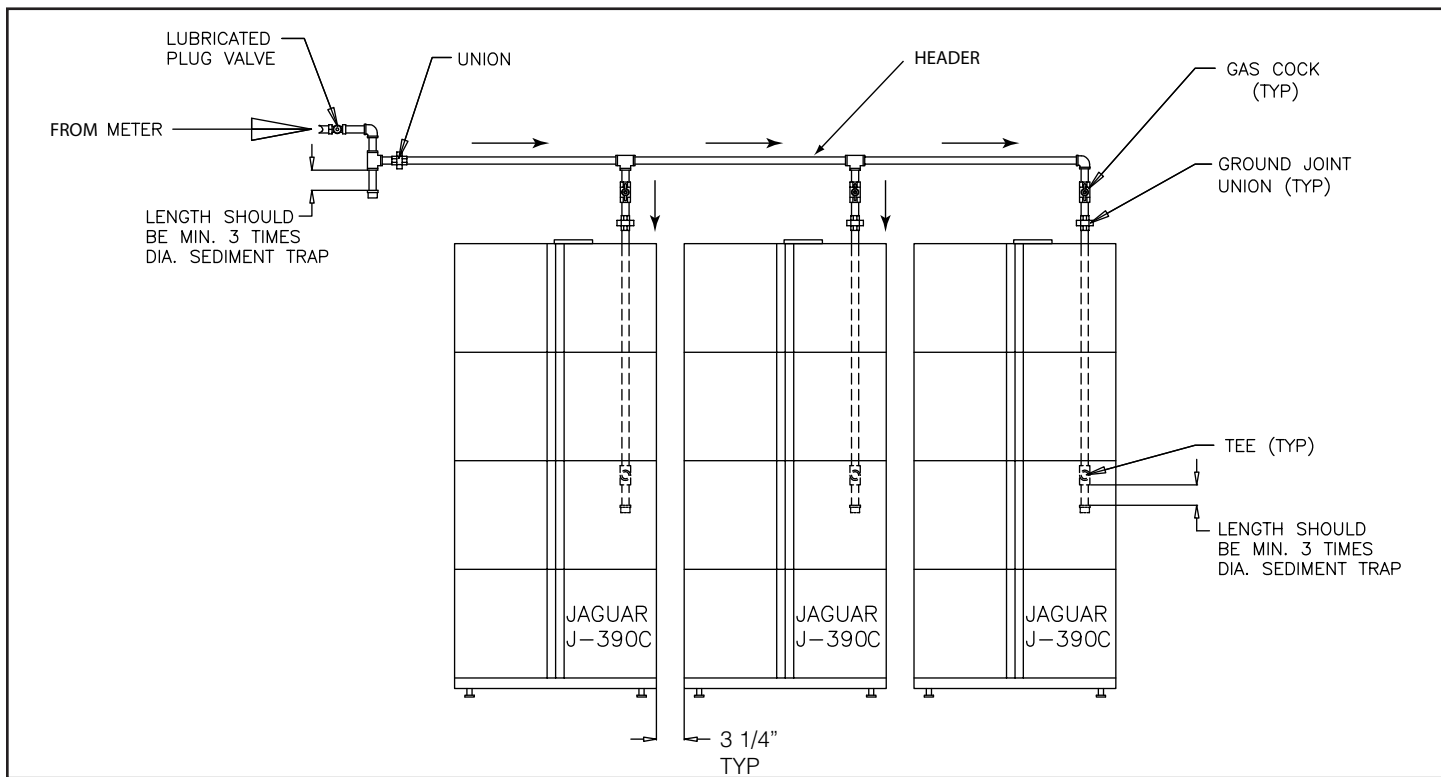
Pipe Size Inches	Elbow			Valve			Return Bend	Side Outlet Tee
	Standard	Medium Sweep	Long Sweep	Gate	Globe	Angle		
1/2	0.84	0.52	0.41	0.031	2.50	1.12	1.25	1.66
3/4	1.17	0.73	0.57	0.044	3.50	1.84	1.75	2.33
1	1.57	0.98	0.77	0.057	4.68	2.11	2.34	3.11
1-1/4	2.19	1.37	1.07	0.082	6.54	2.94	3.27	4.35
1-1/2	2.63	1.64	1.29	0.098	7.84	3.52	3.92	5.21
2	3.55	2.23	1.74	1.320	10.60	4.77	5.30	7.05
3	5.72	3.59	2.81	2.130	17.08	7.69	8.84	11.40

**Table 2. Equivalent linear length in feet of standard iron pipe fittings for natural gas**

Nominal Iron Pipe Size Inches	Internal Diameter Inches	Equivalent Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
3/4	.844	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1-1/4	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1-1/2	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2-1/2	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

**Table 3. Gas main sizing guide**

Maximum capacity of pipe in cubic feet gas per hour for gas pressure of 0.5 psig or less and a pressure drop of 0.3 inch water column (based on a 0.60 specific gravity gas).



**Figure 12. Typical gas supply installation for Jaguar boiler.**

## **JAGUAR MULTIPLE BOILER SYSTEM CONTROL**

The two common control methods for Jaguar Multiple Boiler Systems are listed below.

***1. Jaguar Link:*** Built- Every Jaguar Model J-390C boiler control has built-in cascading abilities for up to a total of 8 Jaguar boilers. Utilization of this feature requires one optional supply water sensor (Slant/Fin Part # 833-433) per Jaguar Multiple Boiler System. The boiler is programmed as the “master boiler” while the other Jaguar boilers are called the “follower boilers”. The master boiler controls the system water temperature as well as determining what Jaguar boilers should operate and what their fuel input should be.

For details on wiring and programming using this method go to Section 10 on page 19 of this manual.

***2. Using External BMS Signal:*** An external control with a 0 to 10 Vdc signal may be used to control a Jaguar Multiple Boiler System. Utilization of this feature requires one optional interface kit (Slant/Fin Part # 830-130) per Jaguar Boiler. This method facilitates control of a Jaguar Multiple Boiler System using external control such as a building automation system. The external control determines system supply water temperature, what Jaguar boilers fire and the fuel input is for each Jaguar boiler.

For details on wiring and programming using this method go to Section 11 on page 28 of this manual.

**10. CONTROL USING BUILT-IN JAGUAR LINK CASCADING METHOD**

Maximum of 8 boilers could be set up for cascading. See page 3 for piping instruction. A water supply system sensor (12 k ohm thermistor) is required to operate and control the system. Slant/Fin system sensor part number is 833433000.

One boiler of the system would be designated as the Master boiler (boiler #1) and all other boilers would be designated as Follower boilers (boiler #2 to 8). Once there is a call for heat, the Master control will turn on the fewest boilers possible to meet the load. The control will bring on and modulate the first boiler from its minimum capacity to its maximum capacity before bringing on another boiler. When another boiler is turned on, the previous boiler will be kept on its maximum rate.

**10.1 ELECTRICAL WIRING**

Schematic and ladder wiring diagrams are shown on figure 7a and 7b.

**DANGER:**  
Before wiring always turn off electric power supply. Otherwise shock or death can result.

Field wiring connections for Jaguar link cascading method must be as follows:

- 9.1.1 Power supply: A separately fused circuit is required for each boiler. Use standard 15 Amp. fuse or breaker and 14 gauge conductors in BX cable or conduit. Provide disconnect means and overload protection as required. Boilers must be electrically grounded in accordance with the requirements of the authority having jurisdiction, or, in the absence of such requirements, with the National Electrical Code, ANSI/NFPA 70- latest edition.  
Connect power supply to terminal #21 (hot) and #22 (neutral). Connect the ground wire to the green ground screw next to the terminal strip.

Proper polarity is critical for the power supply connections. Reversed polarity will cause boiler lockout. Proper grounding is critical for boiler operation.

- 10.1.2 Boiler circulator: Connect boiler circulator to terminal #19 and 20 if the system is for space heating only.
- 10.1.3 System circulator: System circulator must be powered externally and may require the use of relay and a separate power source.
- 10.1.4 Space heating thermostat(s): Install thermostat on an inside wall and away from any heat sources, sunshine and drafts. Connect room thermostat (if used) to terminal #1 and 2 of Master boiler. Use low voltage style thermostats, relays or zone valve end switches (isolated contacts).
- 10.1.5 System water supply sensor: A system sensor (12 K ohm thermistor) is required for the system. Slant/Fin part number is 833433000. Connect sensor wires to terminal #5 and 6 of Master boiler. Follow instruction provided with the sensor for installation.
- 10.1.6 Outdoor air sensor: The outdoor sensor is 12k ohm thermistor supplied with the boiler. Mount the sensor on an outside wall shielded from direct sunlight or flow of heat or cooling from other sources. See instructions provided with the sensor. Connect sensor wires to terminal #5 and 6 of boiler #2.
- 10.1.7 Jaguar link connections: Connect terminal #9 and 10 of Master boiler to terminal #9 and 10 of all individual Follower boilers. See figure 13.

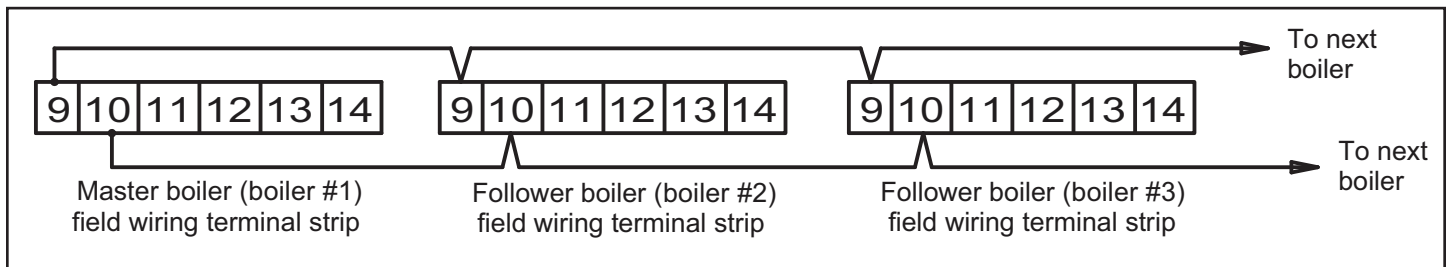


Figure 13. Jaguar link connections.



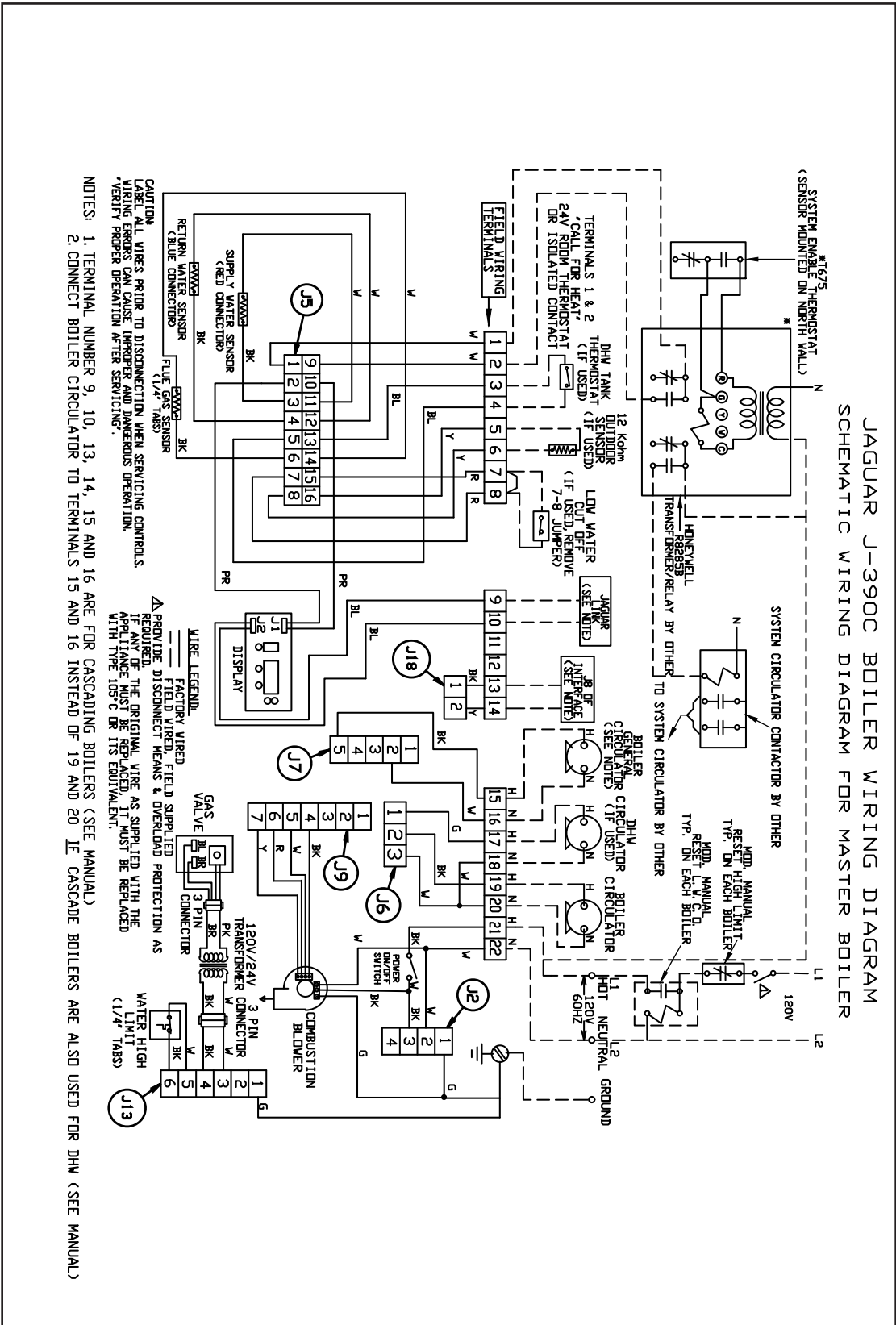


Figure 14.

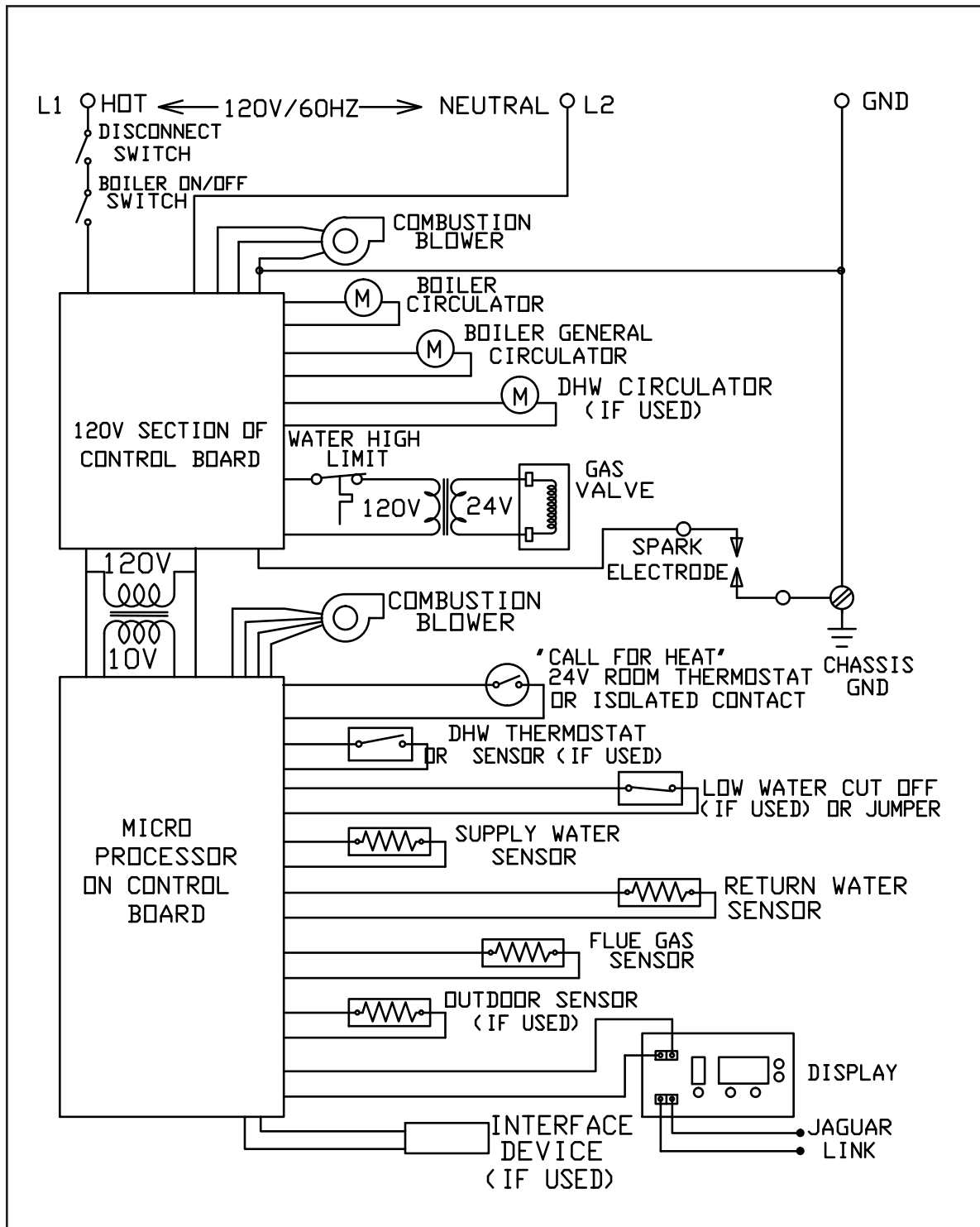


Figure 15.

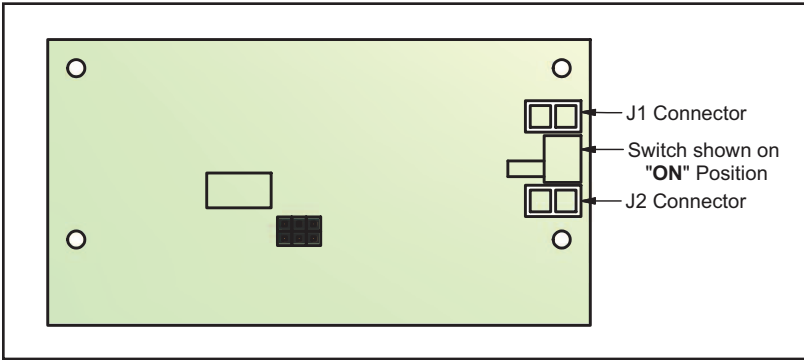


Figure 16. Rear view of the display

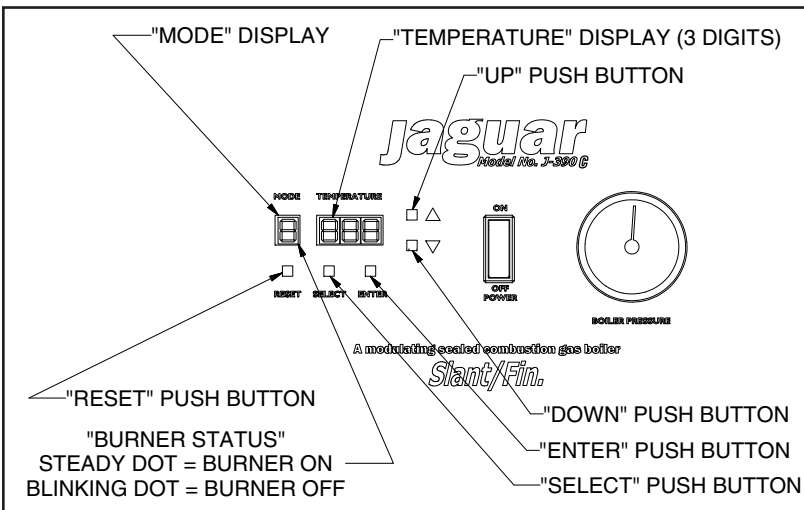


Figure 17. Display Board

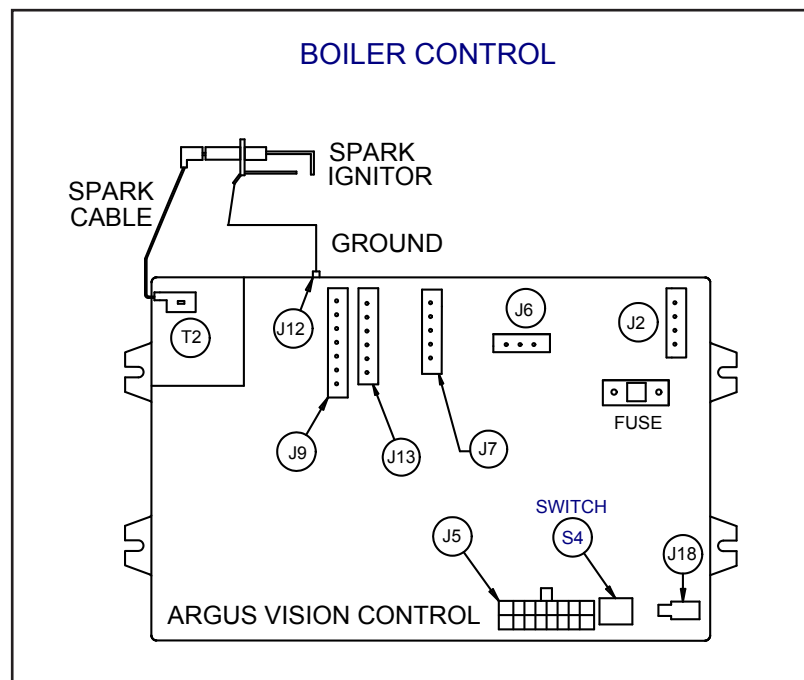


Figure 18. Boiler Control.

**10.2 SET DISPLAYS**

Set the switch on the rear of the displays as follows:

- Master Boiler:** ON (Down Position)
- All Follower boilers:** OFF (Up Position)

See figure 16.

To access to the rear of display, remove the control; panel held in place by 4 screws.

**10.3 Display and push buttons:**

(See figure 17)

1. **Reset** - Used to clear a Lock out error (indicated with an "A" in the "Mode Display").
2. **Select** - Used to scroll through the modes in the "View and Changing Temperatures" and "Viewing and Changing System Setting" menus.
3. **Enter** - Used to store values that are changed in the "View and Changing Temperatures" and "Viewing and Changing System Setting" menus.
4. **Up** - Used to increase values in the "View and Changing Temperatures" and "Viewing and Changing System Setting" menus.
5. **Down** - Used to decrease values in the "View and Changing Temperatures" and "Viewing and Changing System Setting" menus.

**10.4 SETTING BOILERS CONTROL**

Fill system with water. See Installation and Operating Instructions of Jaguar J-390C boiler, Slant/Fin publication J-40. Make sure flue pipes and air intake pipes are installed per venting application section of publication J-40. Each boiler's control must be properly programmed for the system. See table 4 for setting and programming of the boiler's control.

**10.5 Start boilers and set each boiler as follows:**

1. Assign Master and Follower boiler(s) in "b-A" mode. Master address is 1 and Followers addresses are 2 to 8.
2. Select space heating option in "c-t" mode of the Master boiler. Mode 0,1 or 2 may be selected. If mode 1 or 2 (system with outdoor sensor) is selected, weather compensation slope and set point temperatures may be changed in mode "o-d", "o-S" and "o-t". See figure 19, pg 25.
3. Check "A-t" and "A-c" model selection and confirmation modes. The #5 must be shown on display of all boilers.
4. Select boiler space heating (mode "P-c")
5. Boiler rotation: If "r" is set to 1,2,3,4,5,6 or 7, the Master does not always start as the first boiler, Follower boilers also will start as the first boiler. The first starting boiler would be rotated between Master and each Followers in every 1 to 7 days. This feature insures all boilers operate equal hours. Setting "r" to 0 will disable rotation.
6. Combustion test: Run each boiler to check combustion and input rate. See page 37 of J-390C manual (publication J-40).

**10.6 ZONING**

For multiple zoning, either zone valves or circulator (externally powered) may be used. See multi-zoning piping and wiring examples shown in J-390C manual.

**VIEWING AND CHANGING SYSTEM SETTING - Table 4****“To change system setting or perform system test”**

The menu is accessed by pressing and holding “SELECT” and “ENTER” buttons for 10 seconds.

To access different modes: Press “ENTER” button. To change boiler setting: Press “UP or DOWN” button, then press “ENTER”

**WARNING:** Only a trained, experienced service technician or installer should use this table.

MODE DISPLAY	DESCRIPTION
P-c *	Changing space heating post pump time. Settable from 10 to 900 seconds. (steps of 10 seconds). The default value is 30 seconds.
P-d *	Changing DHW post pump time. Settable from 1 to 255 seconds. (steps of 1 seconds). The default value is 15 seconds.
c-t *	Changing space heating control mode 0: Thermostat only (default) - boiler without outdoor sensor 1: Outside sensor and Thermostat 2: Outside sensor only 3: Permanent heat demand (boiler circulator always on) 4: Analog (0-10 V dc) input, 0-10 V controls water supply temperature set point of the boiler. 5: Analog (0-10 V dc) input, 0-10 V controls input rate, Use this option in conjunction with Tekmar control 265 or 275.
d-t *	Changing domestic hot water (DHW) mode 0: No DHW 1: Storage tank with sensor 2: Storage tank with thermostat (default value)
b-t *	Changing DHW or space heating priority mode 0: DHW priority (no time limit) 1: Space heating priority (no time limit) 2: DHW priority for limited time (default) 3: Space heating priority for limited time
b-P *	Changing priority limited time. Settable from 20 to 80 minutes. The default value is 30 minutes.
A-t *	Boiler model selection, value is 5 for model J-390C
A-c *	Boiler model confirmation, value is 5 for model J-390C
o-d *	Weather compensation supply water reference temperature (space heating mode 1 or 2). Settable from 16°F to 122°F (steps of 1 F). The default value is 86°F.
o-S *	Changing compensation slope (space heating mode 1 or 2). Settable from 0.1 to 5.0 (steps of 0.1). The default value is 1.0.
o-n *	Not Utilized
o-t *	Changing weather compensation set point (space heating mode 2 only). Settable from 32°F to 122°F (steps of 1°F). The default value is 68°F.
F **	Display shows blower RPM (multiply reading by 10 for actual RPM)
F-H *	Change blower RPM for high input (steps of 30 RPM, limit +/- 480 RPM).
F-L *	Change blower RPM for low input (steps of 30 RPM, limit +/- 120 RPM).
b-A *	“Boiler’s Assignment” 0: Standalone boiler, no cascading (default) 1: Master boiler (boiler #1) for cascading 2: Follower boiler (boiler #2) 3,4,5,6,7 & 8: Follower boilers (boiler #3,4,5,6,7 & 8)
r **	Cascade Boilers Rotation o: No rotation (default value) 1 to 7: Master or Follower boilers will start as the first boiler in every 1 to 7 days.
S **	Display shows flame current in micro amps
S-0 *	Boiler test – Display shows flame current
S-L	0: System test off
S-I	L: Steady low input (20 minutes)
S-H	I: Steady ignition input (20 minutes)
	H: Steady high input (20 minutes)

**NOTE:** \*: Alternating \*\*: Steady

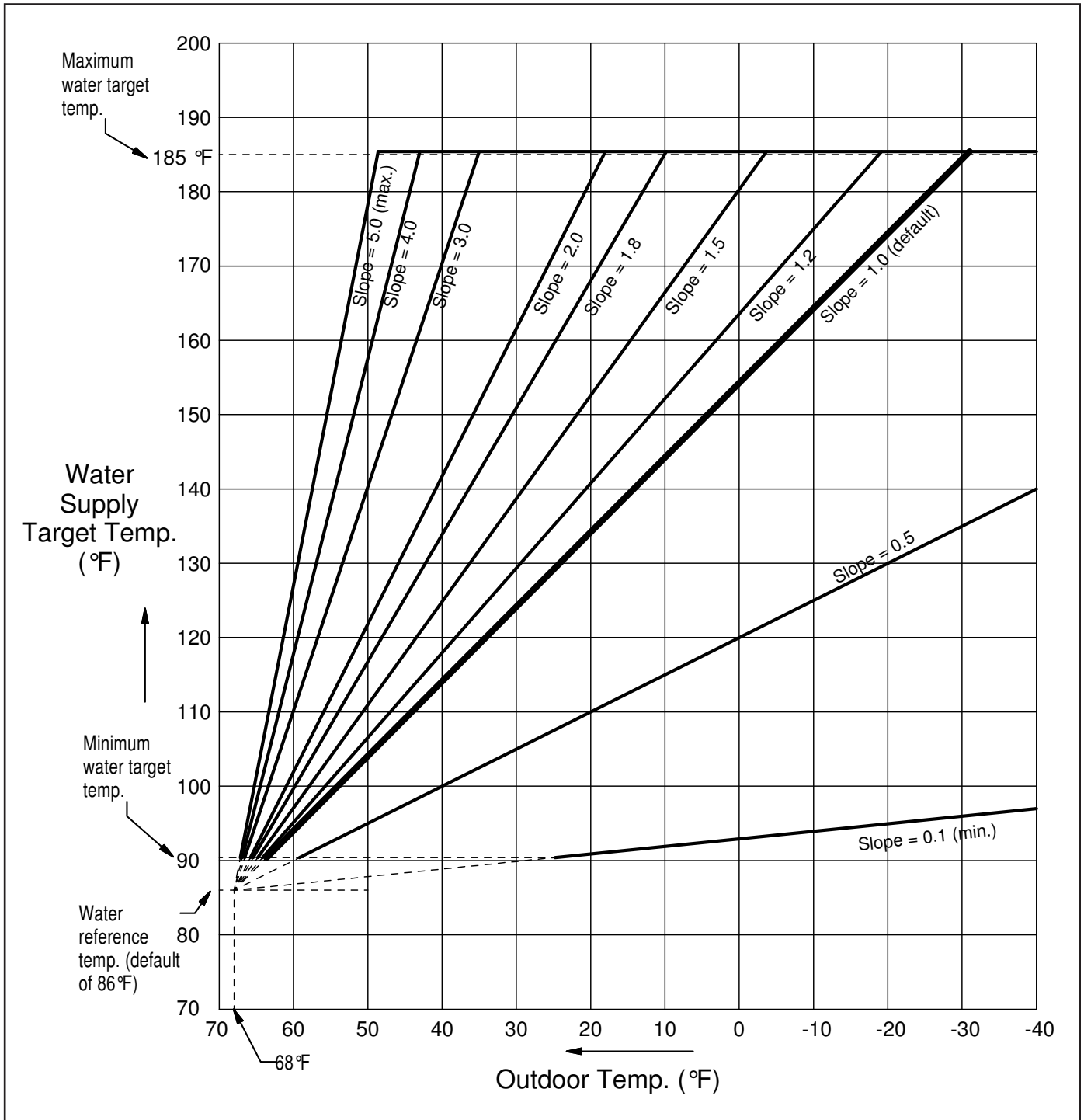


Figure 19. Space Heating mode with outside sensor water set point graph.

**10.7 CHANGING SYSTEM WATER TEMPERATURE**

Setting system supply water temperature for space heating (see table 5):

Press “SELECT” button of Master boiler for viewing different modes on “Mode Display”.

1. While “c” is blinking, system supply water temperature for space heating may be set to desired temperature. The setting range is between 90° to 185°F.
2. While “d” is blinking, system supply water temperature to DHW tank may be set to desired temperature. The setting range is between 104° to 185°F.
3. While “t” is blinking, DHW tank temperature may be set to desired temperature (if tank is equipped with sensor). The setting range is between 104° to 160°F.

**10.8 VIEWING SYSTEM AND MASTER BOILER TEMPERATURES**

Press “SELECT” button of Master boiler for viewing different modes on “Mode Display”. See table 5. View actual boiler supply & return water

temperature flue temperature, outside temperature (if outside sensor is used) and actual system water supply temperature on “Temperature Display” by selecting 1, 2, 3, 4, 5 or 6 on “Mode Display”. View number of boilers are on (includes boilers in lockout or error condition) on “Temperature Display” by selecting “n” on “Mode Display”.

**10.9 VIEWING FOLLOWER BOILER WATER TEMPERATURE**




Press “SELECT” button of Follower boiler for viewing different modes on “Mode Display”. See table 6. View actual boiler supply & return water temperature and flue temperature on “Temperature Display” by selecting 1, 2 or 4 on “Mode Display”.

Note: c, d, t and 3 on “Mode Display” of Follower boilers have no function and are disabled.

**10.10 BOILER OPERATION STATUS**

“Mode Display” shows status of boiler operation “Temperature Display” shows water temperatures lockout, error or warning conditions. See table 7 and 8.

**Table 5**  
***CHANGING SYSTEM WATER TEMPERATURES***  
***AND VIEWING SYSTEM & MASTER BOILER TEMPERATURES***  
 Press “SELECT” button for viewing different modes on “MODE DISPLAY”

MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
 blinking	Space heating system supply water temperature could be changed by pressing “Up/Down” button. Settable from 90°F to 185°F (steps of 1 F). The default value is 176°F. Press “Enter” button to store. (see note 1)
 blinking	System supply water temperature to DHW tank could be changed by pressing “Up/Down” button. Settable from 104°F to 185°F (steps of 1 F). The default value is 176°F. Press “Enter” button to store. (see note 2)
 blinking	Domestic hot water tank temperature could be changed by pressing “Up/Down” button. Settable from 104°F to 160°F (steps of 1 F). The default value is 140°F. Press “Enter” button to store. (see note 3)
1	Temperature display shows actual Master boiler water supply temperature.
2	Temperature display shows actual Master boiler return water temperature.
3	Temperature display shows actual DHW tank temperature. (if the water tank is equipped with sensor).
4	Temperature display shows actual flue gas temperature.
5	Temperature display shows actual outside temperature. (if outdoor sensor is used)
6	Temperature display shows actual system water supply temperature
n	Temperature display shows number of Caravan boilers are on (includes boilers in lockout or error condition)

- NOTE:**
- 1- For space heating mode “0” (system not utilizing outdoor sensor)
  - 2- For DHW mode “2” (storage tank with Aquastat)
  - 3- For DHW mode “1” (storage tank with sensor)



Table 6

**VIEWING FOLLOWER BOILER WATER TEMPERATURES**

Press “SELECT” button for viewing different modes on “MODE DISPLAY”




MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
 blinking	NO FUNCTION
 blinking	NO FUNCTION
 blinking	NO FUNCTION
1	Temperature display shows actual supply water temperature.
2	Temperature display shows actual return water temperature.
3	NO FUNCTION
4	Temperature display shows actual flue gas temperature.
5	Temperature display of boiler #2 only shows actual outside temperature. (if outdoor sensor is used)

Table 7

**MASTER BOILER DISPLAY BOARD**

*“Boiler Operation Status”*

MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
0	Master boiler is on stand-by mode. Temperature display shows system supply water Temp.
c	Space heating mode. Temperature display shows system supply water Temp.
d	Domestic hot water mode. Temperature display shows system supply water Temp.
F	Frost protection mode. ** Temperature display shows system supply water Temp.
A	Lockout (Alarm) condition. Temperature Display indicates the lockout code Reset button must be pressed to resume normal operation.
E	Error Condition. * Temperature display indicates the error code.
H	Warning Condition. *** Temperature display indicates the error code.

**NOTE:** Blinking dot on “Mode Display” indicates active heating control, burner off.  
Steady dot indicates burner is on.

\*: Error must be corrected to resume boiler operation. Pressing the “Reset” button is not required.

\*\*: The boiler loop circulator is energized, if the boiler water temperature drops below 50°F.

\*\*\*: Error must be corrected to resume DHW operation. Space heating not affected. Pressing the “Reset” button is not required.

**Table 8**  
***FOLLOWER BOILER DISPLAY BOARD***  
***“Boiler Operation Status”***

MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
0	Follower boiler is on stand-by mode. Temperature display shows boiler supply water Temp.
C	Heating mode. Temperature display shows boiler supply water Temp.
F	Frost protection mode. ** Temperature display shows boiler supply water Temp.
R	Lockout (Alarm) condition. Temperature Display indicates the lockout code Reset button must be pressed to resume normal operation.
E	Error Condition. * Temperature display indicates the error code.
H	Warning Condition. *** Temperature display indicates the error code.

**NOTE:** Blinking dot on “Mode Display” indicates active heating control, burner off.  
Steady dot indicates burner is on.

\*: Error must be corrected to resume boiler operation. Pressing the “Reset” button is not required.

\*\* : The boiler loop circulator is energized, if the boiler water temperature drops below 50°F.

\*\*\*: Error must be corrected to resume DHW operation. Space heating not affected. Pressing the “Reset” button is not required.

## 11. CONTROL USING EXTERNAL BMS SIGNAL

An external control with 0-10 Vdc output such as Tekmar 265 or 275 could be used to operate up to 4 boilers. One special interface control is required for operation of each boiler in the system. Use Slant/Fin interface kit (Part no. 830130). Kit includes interface control and 3 different harnesses needed for connection of Tekmar control to the interface and the boiler. See figure 20. Follow Tekmar control manual D275 for installation and operating instructions. Install interface control next to the Tekmar control.

Some local codes require 120 volt wiring to be encased within a flexible or non flexible electrical conduit. Local codes may require the interface control be mounted within an approved electrical box. Follow code requirements for the jurisdiction where the boiler is being installed.

### 11.1 ELECTRICAL WIRING

**DANGER:** Before wiring always turn off electric power supply. Otherwise shock or death can result.

#### 11.1.1 Power supply:

A separately fused circuit is required for power connection to each boiler. Use standard 15 Amp fuse or breaker. Provide disconnect means and overload protection as required. Boilers must be electrically grounded in accordance with the requirements of the authority having jurisdiction, or in the absence of such requirements, with the National Electrical Code, ANSI/NFPA 70- latest edition.

Use harness P/N 832112 (see figure 20) to connect power supply to J1 connector of interface control. See figure 21. Use BX cable or conduit for power supply connection. Proper polarity is critical for power supply connections. Reversed polarity will cause boiler lockout. Proper grounding is also critical for boiler operation.

#### 11.1.2 Interface control connection to the boiler:

Use harness P/N 832114 to connect interface J8 connector to terminal #13 and 14 of the boiler. See figure 23.

#### 11.1.3 Connecting Tekmar control 275 to interface control:

Use harness P/N 832115 to connect J5 connector of interface to Tekmar control terminal # 7 & 8 (boiler No. 1) or terminal # 8 & 9 (boiler No. 2) or terminal 10 & 11 (boiler No.3) or terminal 11 & 12 (boiler No. 4). See figures 20 and 21.

#### 11.1.4 Boiler, DHW and system circulators connection:

See Tekmar application brochure A275 for different piping arrangements and electrical connections.

#### 11.1.5 Outdoor and system water supply sensors:

See Tekmar manual A275 and D070 for installation instruction and wire connection. Use sensors supplied with the Tekmar control or recommended by Tekmar. Tekmar control sensors are NTC thermistor 10 K ohm.

*Note: Do not connect any other sensor(s) directly to the boilers.*

#### 11.1.6 Important:

Set the switch in the interface control to "OFF" position. See figure 21.

## 11.2 SETTING BOILER'S CONTROL FOR EXTERNAL SIGNAL

Fill system with water. See Installation and Operating Instruction of Jaguar J-390C boiler (Publication J-40). Make sure flue pipes and air intake pipes are installed per venting application section of the above-mentioned manual. Each boiler's control must be properly programmed for the system. See table 4 for setting and programming the controls.

#### Set each boiler's control as follow:

1. Select option #5 in "c-t" mode
2. Select option #0 in "b-A" mode
3. Check "A-t" and "A-c" in model selection and confirmation modes show #5, if not, set to #5.
4. Set Tekmar control: Follow Tekmar manual D275 to set control for selected application. Sequential or parallel modulation mode may be selected for boilers operation.
5. Combustion test: Run each boiler to check combustion and input rate. See page 37 of J-390C manual (Publication # J-40).

## 11.3 VIEWING BOILER WATER TEMPERATURE

Press "Select" button for viewing boiler supply water, return water and flue gas temperature on "Temperature Display". See table 9.

## 11.4 BOILER OPERATION STATUS

"Mode Display" shows status of boiler operation. See table 10 "Temperature Display" shows boiler's water temperature, lockout or error condition.

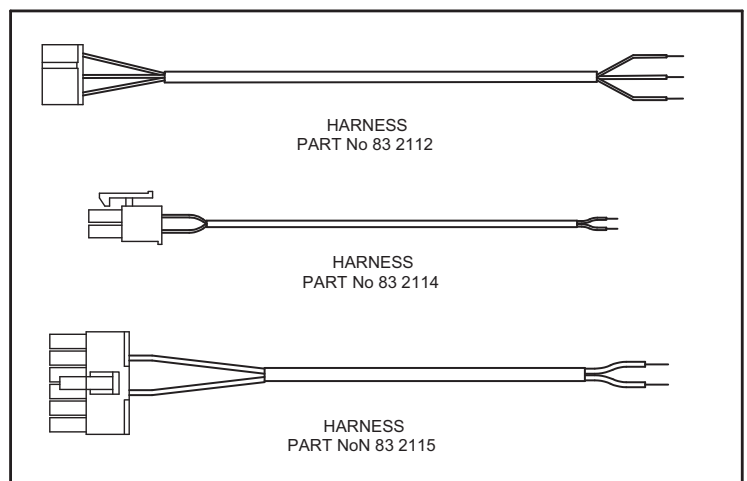


Figure 20. Harnesses packed with Interface kit.

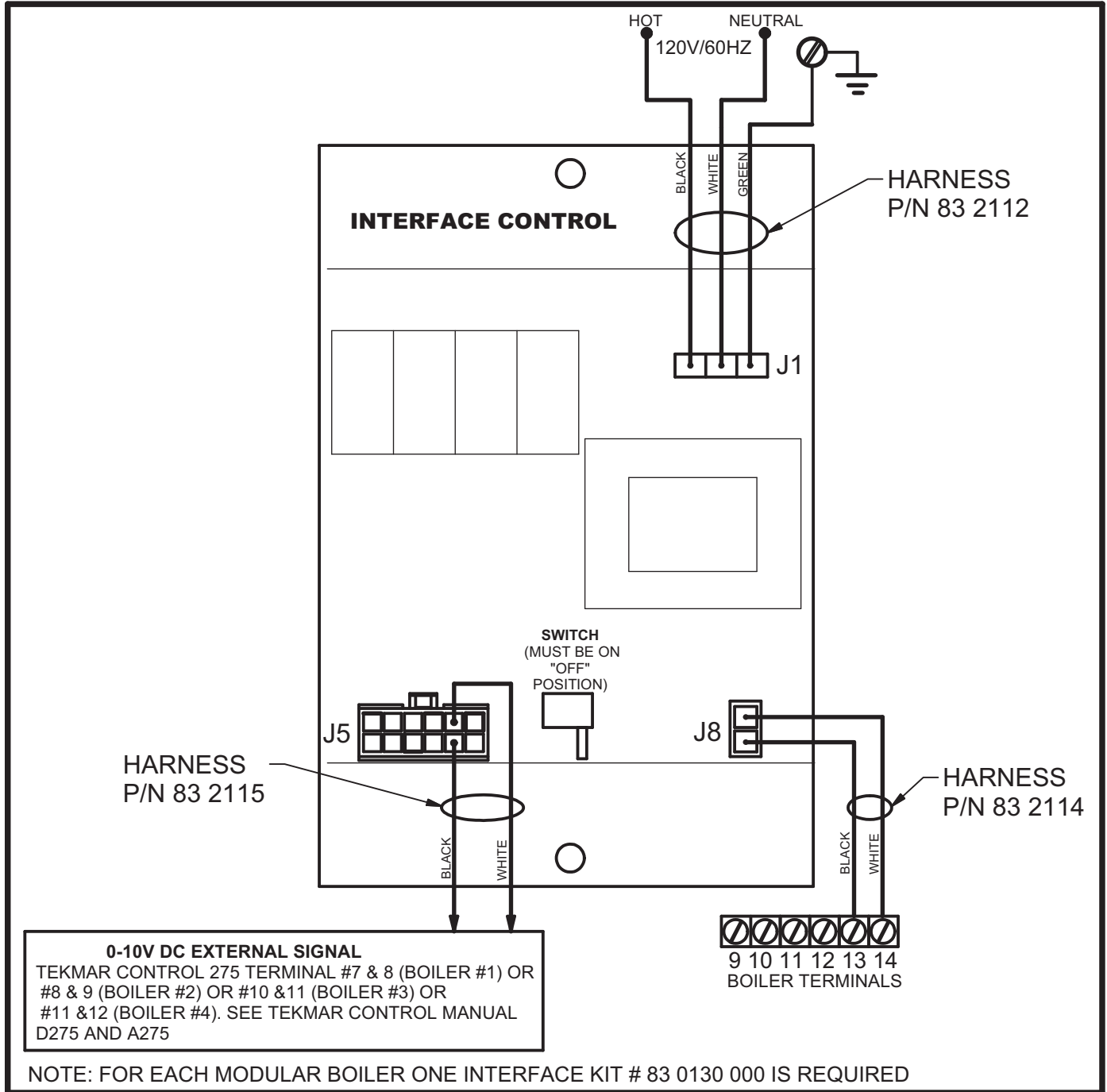





Figure 21. 0-10V DC External signal connection to interface control and J-390C boiler.

**Table 9**

**VIEWING BOILER WATER TEMPERATURES**

*Press “SELECT” button for viewing different modes on “MODE DISPLAY”*

MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
 blinking	NO FUNCTION
 blinking	NO FUNCTION
 blinking	NO FUNCTION
<b>1</b>	Temperature display shows actual boiler supply water temperature.
<b>2</b>	Temperature display shows actual boiler return water temperature.
<b>3</b>	NO FUNCTION
<b>4</b>	Temperature display shows actual flue gas temperature.
<b>5</b>	NO FUNCTION

**Table 10**

**JAGUAR BOILER DISPLAY BOARD**

*“Boiler Operation Status”*

MODE DISPLAY	DESCRIPTION & TEMPERATURE DISPLAY
<b>0</b>	Boiler is on stand-by mode. Temperature display shows boiler supply water Temp.
<b>C</b>	Heating mode. Temperature display shows boiler supply water Temp.
<b>F</b>	Frost protection mode. Temperature display shows boiler supply water temperature.
<b>A</b>	Lockout (Alarm) condition. Temperature Display indicates the lockout code Reset button must be pressed to resume normal operation.
<b>E</b>	Error Condition. * Temperature display indicates the error code.

**NOTE:** Blinking dot on “Mode Display” indicates active heating control, burner off.  
Steady dot indicates burner is on.

\*: Error must be corrected to resume boiler operation. Pressing the “Reset” button is not required.

**DIAGNOSTIC ERROR CODES**

**LOCKOUT ERRORS:** Indicated by an "A" in the mode display. The reset button must be pressed to clear the error and retry operation. The temperature display shows the error code.

<b>ERROR CODE</b>	<b>INDICATION</b>	<b>REMEDY</b>
<b>01</b>	Ignition Failure - 3 unsuccessful ignition attempts in a row.	Check for steady sparking at electrodes. If spark not steady - check spark gap to be .125", clean or replace spark ignitor, check power supply voltage and grounding. If spark is steady - check for proper gas supply pressure. Check combustion, if able to ignite, or replace gas valve.
<b>02</b>	Flame Failure - 3 losses of flame signal during one demand.	Check for proper combustion, at both max. and min. input firing rates. If combustion is within the range specified on page 37 of J-390C manual, clean or replace spark ignitor, check power supply voltage and grounding.
<b>03</b>	Water High Limit Open	Check to see if the water outlet temperature reaches 203°F. If it does, replace the water outlet 12k ohm sensor. If it does not, replace the water high limit switch.
<b>04, 05, 09, 10, 12, 13, 14, 15, 16, 18, 32</b>	Control Failure	Replace control board. Make sure the proper boiler model selection and confirmation code is entered. See Table 4.
<b>19, 20</b>	Flame Detected at Wrong Time	If a flame is still observed after a call for heat is stopped, replace the gas valve. If the burner seems to be shutting down properly, replace the spark ignitor.
<b>33</b>	Fan Failure - RPM error	Check wire harness connections going to the blower. Replace blower.



**BLOCKING ERRORS:** Indicated by an “E” in the mode display. Operation is automatically restored, once the condition returns to normal or is fixed. The temperature display shows the error code. Pressing the “Reset” button is not required.

ERROR CODE	INDICATION	REMEDY
<b>01</b>	Water Outlet Sensor Open	Check wire harness connections going to the sensor. Replace the sensor.
<b>02</b>	Water Inlet Sensor Open	Check wire harness connections going to the sensor. Replace the sensor.
<b>03</b>	Flue Gas Sensor Open	Check wire harness connections going to the sensor. Replace the sensor.
<b>05</b>	System Sensor Open	Check wires going to the sensor and connections. Replace the sensor.
<b>11</b>	Water Outlet Sensor Shorted	Replace the sensor.
<b>12</b>	Water Inlet Sensor Shorted	Replace the sensor.
<b>13</b>	Flue Gas Sensor Shorted	Replace the sensor.
<b>15</b>	System Sensor Shorted	Check wires going to the sensor and connections. Replace the sensor.
<b>19, 42, 45, 46, 47, 48</b>	Control Failure	Replace control board. Make sure the proper boiler model selection and confirmation code is entered. See Table 4.
<b>20</b>	Flame Detected at Wrong Time	If a flame is still observed after a call for heat is stopped, replace the gas valve, If the burner seems to be shutting down properly, replace the spark ignitor.
<b>21</b>	Polarity Error	Reverse the hot and neutral power supply wires.
<b>22</b>	Frequency Error	Check power supply frequency to be 60 hz, certain power supplies may not provide the proper frequency.
<b>24</b>	Earth Connection Faulty	Check grounding of control and boiler chassis.

*continued on page 25*

continued from page 24

ERROR CODE	INDICATION	REMEDY
30	Excess Flue Temperature	Check flue gas temperature, at the maximum firing rate and high water temperature. If the flue gas temperature reaches 212°F, check the fuel input rate and combustion. Check the condition of the heat exchanger. If the flue gas temperature does not reach 212°F, replace the flue sensor.
31	Low Water Cutoff Error	If a low water cutoff is installed, check the system water pressure and correct. Check the condition of the LWCO. If no LWCO is installed, check the jumper is in place at the wiring terminal board. See Figure 14.
32	Excess Water Inlet Temperature	Check that the wire harnesses to the water inlet and outlet sensors are not reversed. The water inlet sensor harness should have a blue colored connector, the water outlet sensor harness should have a red colored connector. Check that the pumping flow direction is correct.
51	Reset Button Error	Try turning power supply off and on again. If error returns, replace the display board.
52	Boiler Model Selection Error	Check that the proper boiler model selection and confirmation code is entered in the display. See Table 4.

**6.3 WARNING ERRORS:** Indicated by an “H” in the mode display. Operation of the space heating mode is not affected, and the warning is displayed intermittently. Operation of the DHW mode is automatically restored, once the condition is fixed. The temperature display shows the error code. Pressing the “reset” button is not required.

04	Domestic Hot Water Tank Sensor Open	If sensor is utilized, check wire harness connections going to the sensor, or replace the sensor. If no sensor is utilized, check the proper DHW mode is programmed. See Table 4.
14	Domestic Hot Water Tank Sensor Shorted	If sensor is utilized, replace the sensor. If no sensor is utilized, check the proper DHW mode is programmed. See Table 4.

## 12. Hybrid Condensing/Non-Condensing Boiler Systems

A “Hybrid Condensing/Non-Condensing Boiler System” is a combination of condensing and non-condensing boilers working together to heat a building. The predominant reasons to use a hybrid system are lower installed cost and optimizing system efficiency. In this chapter we discuss why a hybrid boiler makes sense and how to design a hybrid boiler system.

Within the ASHRAE Equipment Handbook the subject of condensing or non-condensing boiler is covered. Figure 1 of this chapter in the Handbook (Effect of Inlet Water Temperature on Efficiency of Condensing and Non-Condensing Boilers) is a graph illustrating the relationship between inlet boiler water temperature and boiler efficiency. The dew point or start of condensation of the water vapor in the products of combustion for natural gas starts around a 130 F return water temperature. Above that temperature condensation does not occur and as the water temperature decreases below the 130 F the amount of water vapor condensed increases. As the amount of condensate increases the boiler efficiency increases. Typically a 90% boiler efficiency is achieved when the water temperature is 120F or lower. The lower the water temperature, the higher the boiler efficiency and conversely as the water temperature increases the boiler efficiency decreases. With a 180F water temperature the boiler efficiency is around 86%. This is just plain physics.

A properly controlled “hybrid condensing/non-condensing boiler system” operates the condensing boilers when the water temperature is low enough for condensing to occur and when the water temperature is above that point the non-condensing boilers handle the load. With water temperatures below 130F condensing boilers operate and when the water temperature is above 130F the non-condensing boilers take over.

The system designer determines the heat load for the heat emitters when the water temperature is at 130F. This load is used to size the condensing boiler used in the hybrid system. Slant/Fin does publish residential baseboard and commercial radiation output ratings down to 110F water temperature. If the heating system is designed to satisfy

the full heating load under design conditions with a water temperature at or below 130F, then a boiler plant using only condensing boilers makes sense.

The non-condensing boiler of a hybrid boiler system is sized to handle 100% of the heating load. When the water temperature is above the 130F, the non-condensing boiler does handle 100% of the load. After all, water temperatures required in a heating system increase as the outdoor temperature drops and the load increases.

A properly applied hybrid boiler system will optimize efficiency and be cost effective. There will be a faster payback for the boiler plant and higher return on investment.

A Slant/Fin hybrid boiler system consists of Jaguar modulating/condensing boilers installed with Caravan modular cast iron boilers. Since modular boilers inherently have built-in back up, a boiler system can be sized closely to the calculated heat load. This helps decrease the initial cost of the boiler system further.

A Slant/Fin hybrid boiler system is controlled so the system control modulates the input of the Jaguar boilers and then step fires the Caravan modular boiler while resetting system water temperature. The result is a simple system that delivers high efficiency while improving system control and dependably. One control for a hybrid boiler system is the Heat Timer CNC Control, CNC stands for “condensing and non-condensing”. Heat Timer can be reached at 201-575-4052.

The water piping of a Slant/Fin hybrid boiler system is simple. Slant/Fin recommends “injecting” the condensing boiler water into either the supply or the return water piping of the Caravan modular boiler, please see figure 22. This drawing shows 2 each J-390C Jaguar boilers and 3 each GGT modules used in one hybrid boiler system. Jaguar boilers can also be added to existing boiler systems provided there is room to do so.

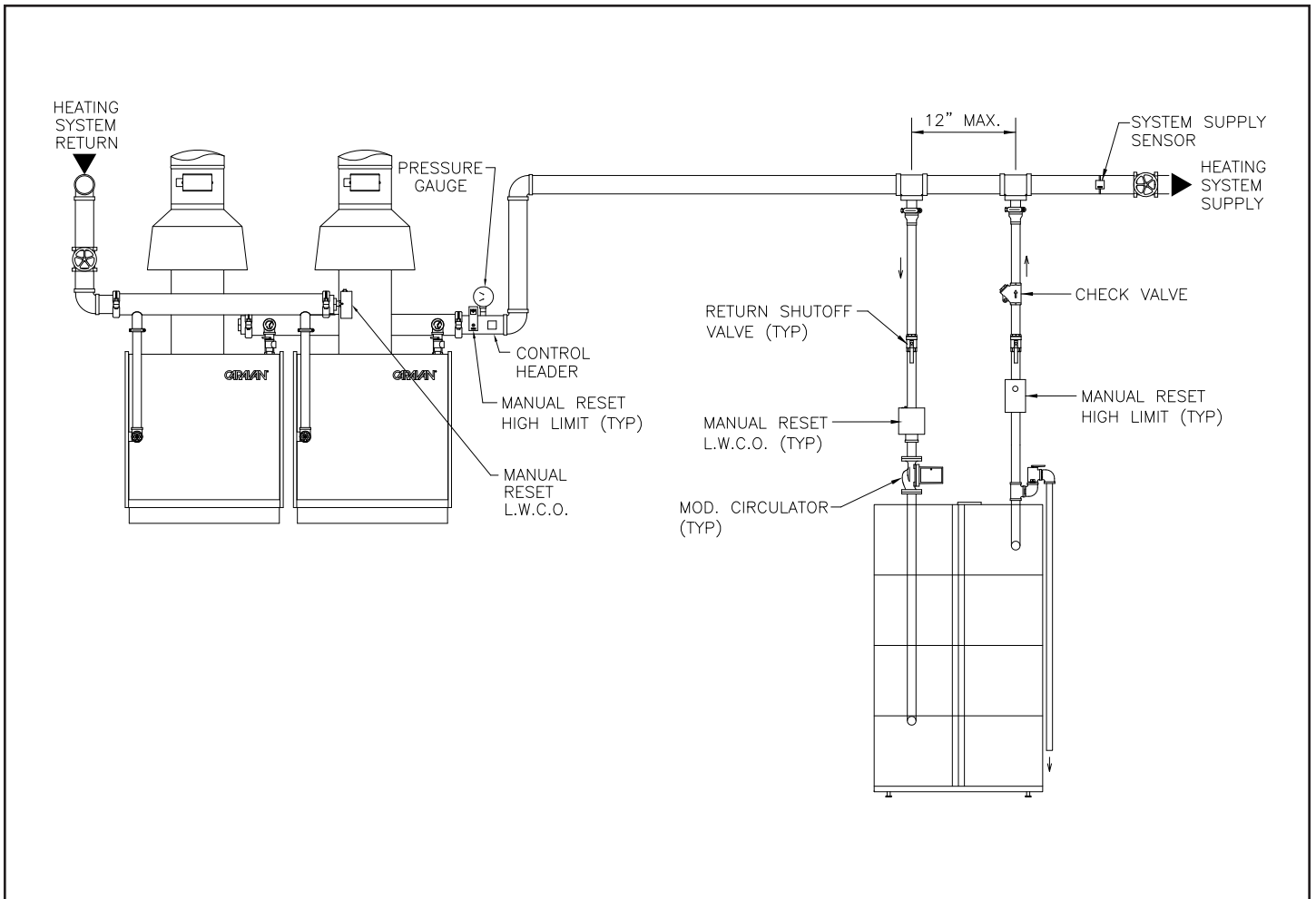


Figure 22. Hybrid Boiler System.