General

AERCO KC Boilers are designed for use in any hydronic closed loop heating system application within the limitations of temperature and pressure ratings. Due to their extreme flexibility and precise control, they can be used to supplement any hot water system. This guide is intended to help designers apply AERCO boilers to the most common types of systems. If a special application is needed, please call your local AERCO Representative or the AERCO factory for specific application information.

Single and Multiple Applications

The AERCO KC Boiler can be applied either as a stand alone *Single* unit or as a *Modular* battery of boilers with unlimited input. KC multiple boiler systems provide inherent standby, minimize floor space required, and, most importantly, modulate to match the changing requirements of the load under partial loads. Actual boiler sizing and selection are the responsibility of the designer. ASHRAE Standards recommend sizing equipment with a minimum of oversizing for maximum system efficiency. A multiple KC Boiler installation matches any load fluctuation from 0 to 100% without overshoot. AERCO subscribes to and recommends the methods utilized by ASHRAE and IBR to develop proper loads and sizes required. Combination plant sizing is recommended directly from the ASHRAE System Manual.

Piping

Pressure, Temperature, and Flow Restrictions

KC Series units are ASME certified for working pressures of up to 150 psig. KC Boilers can not be used in applications where this pressure rating can be exceeded or irreparable damage may result. Individual ASME pressure relief valves are supplied on each boiler in setpoints of 30, 50, 75, 100, or 150 psig as specified.

AERCO KC Boilers require a minimum of 25 gpm flow per boiler for proper and stable boiler control operation. Maximum flows are limited to 150 gpm to prevent erosion of construction materials. Whenever KC boilers are employed into systems where. ancillary flow devices (such as three-way valves) are used, minimum flows must be maintained for proper boiler operation. Due to excellent heat exchanger design, the water side pressure drop through KC boilers is negligible.

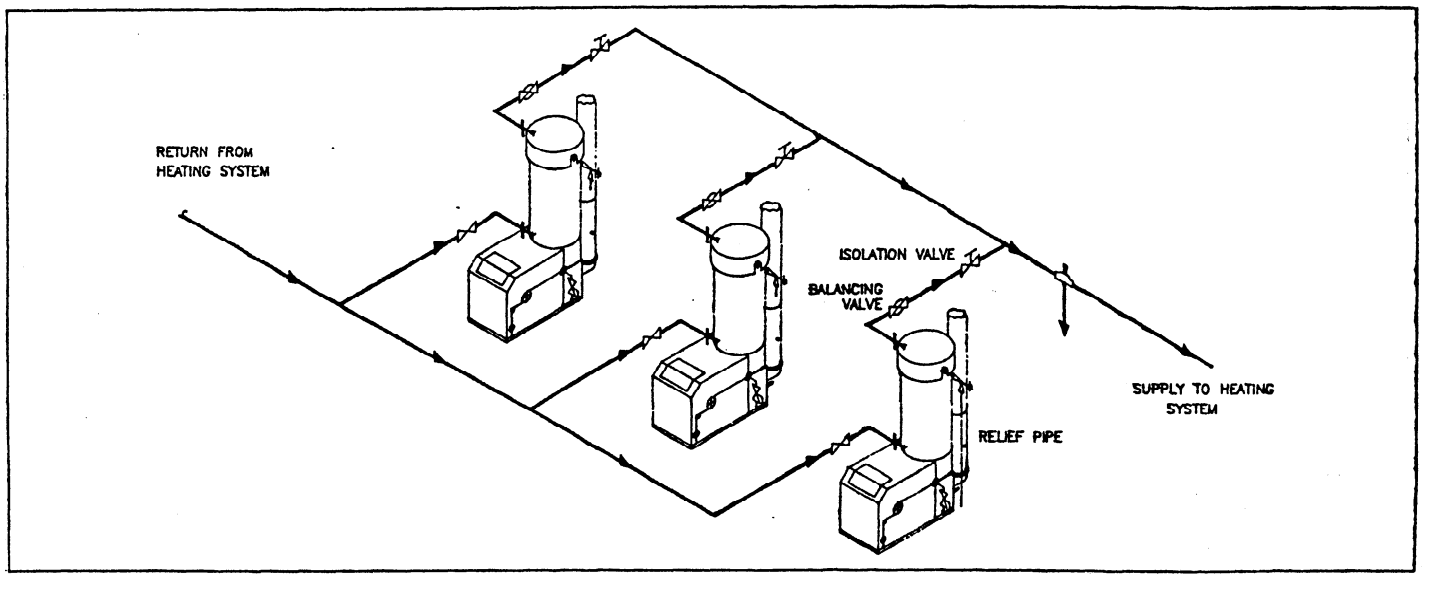
KC units are applicable to systems with temperatures from 50F to 220F. Due to their condensing design, normal low temperature restrictions do not apply. While most common heating applications are designed with a 20F temperature drop, KC boilers are capable of 100F temperature drop through the heat exchanger without thermal stress.

Primary vs. Secondary Flow

The low pressure drop through the heat exchanger of AERCO KC boilers makes primary pumping of system water directly through the boiler shell by the system circulating pumps most efficient. Electrical and extra pump costs are eliminated. Standby losses suffered with common natural draft type boilers are not experienced with AERCO Boilers. KC units have tight air flow control when units are off.

Due to their condensing nature, water temperature limitations restrictive to non-condensing boilers do not apply. KC boilers have a temperature range of 50F to 220F, providing a large application range. For low temperature systems such as water source heat pump or low temperature chiller supplement, system flows can directly interface with the boiler heat exchanger.

Diagram 1
Proper Modular Boiler Piping



Multiple Boiler Piping Design

When more than one KC boiler is to be used in a system with common operating controls, a balanced flow piping design must be used. Each boiler must be fitted with an adjustable orifice balancing valve. The failure to balance flow evenly through boiler modules will prevent full delivery of boiler capability at design conditions.

Valving and Service Provisions

Each KC Boiler should be individually valved on supply and return from the system for maintenance and standby. As each is individually protected by safety controls, there are no extra controls or labeling required. System components, such as fill valves and air separation equipment, are not required for each individual boiler unless a condition of local code. Boilers should be properly spaced to allow for installation of valving and service between units. Piping should be located to allow free access between boilers. Each unit has an individual factory installed drain in the boiler shell so no field piping drain is required.

Hydronic System Accessories

AERCO KC Boilers must be used in conjunction with appropriate hydronic accessories such as pumps, expansion tanks, air elimination equipment, etc. System design should be towards a minimum of operator maintenance required. Normal commercial and industrial systems employ constant-run pumping equipment. Controls should activate heating pumps whenever KC Boilers are in operation. Also, air elimination in conjunction with pre-charged diaphragm expansion tanks is preferable to air control. Compression tanks may be used but create a maintenance job for the operators. Make-up systems must be employed as required by codes. Fill valves must be used with backflow preventors as required. Pumps, three-way valves, or other flow devices should always provide the minimum flows required for a single or multiple boiler installation. Consult your local AERCO representative for proper application advice.

Condensate Piping

Each AERCO KC boiler has a separate indirect condensate drain that must be permanently piped as part of the installation. The condensate produced is less acidic than a carbonated soft drink, and **is** safe for all types of drainage systems.

Condensate can be drained by gravity to a floor drain, or drained into a small condensate pump (such as used with air conditioning equipment) and pumped to a convenient drain. Each unit will produce under 2 gallons per hour in the full condensing mode. In modular applications it is common to manifold these drains together in a plastic pipe manifold to a floor drain. Condensate manifolds must be large enough to handle the flow anticipated and be properly secured and protected. They are generally located behind the modules for short runs of plastic tubing into the manifold from the condensate drain.

When each unit is individually drained, the drain line from the heater to the drain should be large enough to allow air venting from the heater drain cup. Too small a drain line will cause backup and the cup to overflow.

Controls

Safety Controls

KC Boilers are equipped with a high limit aquastat and a secondary safety high limit aquastat. Every KC Boiler has safety controls in accordance with ASME Section IV for low pressure heating boilers. These controls are factory wired and installed to simplify field installation. An internal electric probe type low water cutoff, and a manual reset high limit temperature device comply with ASME standards. Other local requirements for external safety devices (flow switches, pressuretrols, etc.) should be provided and installed locally. Designers should check with local authorities having jurisdiction to assure compliance with all applicable codes.

Internal Boiler Operating Control Options

KC boilers are complete with both combustion safeguard controls and operating controls in each unit. When applied in a single application, boiler control modes must be specified and ordered with:

Order Code	Description	Output
3	Internal Setpoint	- Constant Discharge Temp
2	External Setpoint	- Indoor/Outdoor Reset
4	4-20ma Remote Signal	- Linear response to external applied signal

Factory software and testing allow a simple installation, with minimum field wiring required.

When more than one KC boiler is applied in a modular application with an AERCO Boiler Management System (Model 168), the modules should be specified and ordered as 'BMS' compatible (Order Code 5). Simple field control wiring of two twisted wires connects the BMS Panel to the individual modules.

For boiler plants that will both provide space heating and domestic water production of common modules, 'Combination' option (Order Code 6) should be specified. KC units with Order Code 6 are capable of firing to a constant temperature, such as an internal setpoint boiler would, and are also able to modulate in response to a BMS signal when transferred into the heating mode. These units MUST be piped in field to the hot water generator, and therefore must be identified before the installation is begun.

For small applications it may be desirable to utilize boilers with individual operating controls. Particularly for modular installations of two modules, it may be preferable to set the two units up to operate in parallel. This will result in efficient operation without the expense of a central boiler management system.

Field Sensor Location

When a single KC Boiler is used, all water sensors are internal to the boiler unit and factory positioned. When multiple boilers are used, with common sensors such as the Header Sensor, the water sensor must be located in

the field piping. It should be placed in the common supply at least 3-5 feet downstream of the point where the last module connects into the supply header.

All outdoor air sensors should be positioned on the North wall of the building served, and not in direct sunlight. A sunshield is provided as part of the outdoor air sensor kit.

Modular Boiler Control

For maximum efficiency and flexibility of operator control, an AERCO Boiler Management System (BMS) should be used with a modular KC application. The Model 168 BMS has the capability of controlling up to eight modules as well as auxiliary equipment. Refer to BMS-1 Model 168 specification sheet for full details of the BMS flexibility. When used with a BMS, KC units should be specified and ordered with the BMS control configuration (Order Code 5) from the factory.

Typical Applications

KC Boilers can be used in any closed loop heating system within the design limitations of the individual modules. The following typical piping and wiring schematic diagrams represent only the most common types of installation detail. They are not intended for any particular system, but are rather composites of how Aerco boilers interface with heating applications in the real world. The designer is encouraged to consider all the possibilities and benefits in applying the KC boiler to system in the manner that most uses the energy saving aspect of them. With ultimate control over the energy transfer process, and a broad range of temperatures not available before, consider first how the system best needs the energy inputted. Then, apply the boilers in the manner that best allows them to use their finite control and capability to supplement the system using a minimum of energy.

The, following examples consist of piping and wiring diagrams with brief explanations of design considerations and sequences of operation. The examples used are:

1. Single Heating Boiler- External Reset Control Mode (1/0)
2. Four Module Heating Plant-External Reset Mode with BMS-168
3. Two Module Plant-Internal Reset Mode (Water Source Heat Pump System)
4. Three Module Combination Heating & Domestic Water Plant-External Reset

Designers are encouraged to work with their Aerco representative to fully explore and apply the *ultimate exchange of energy with control* in hydronic heating.

1. Single Heating Boiler-Heating Only

Sequence of Operation

Boiler plant should be activated by a system start device such as an outdoor air thermostat or building management system. A manual switch can be used but it puts the burden of starting and stopping on the boiler attendant. Automatic controls are more desirable.

Diagram 2
Single Boiler Piping Schematic

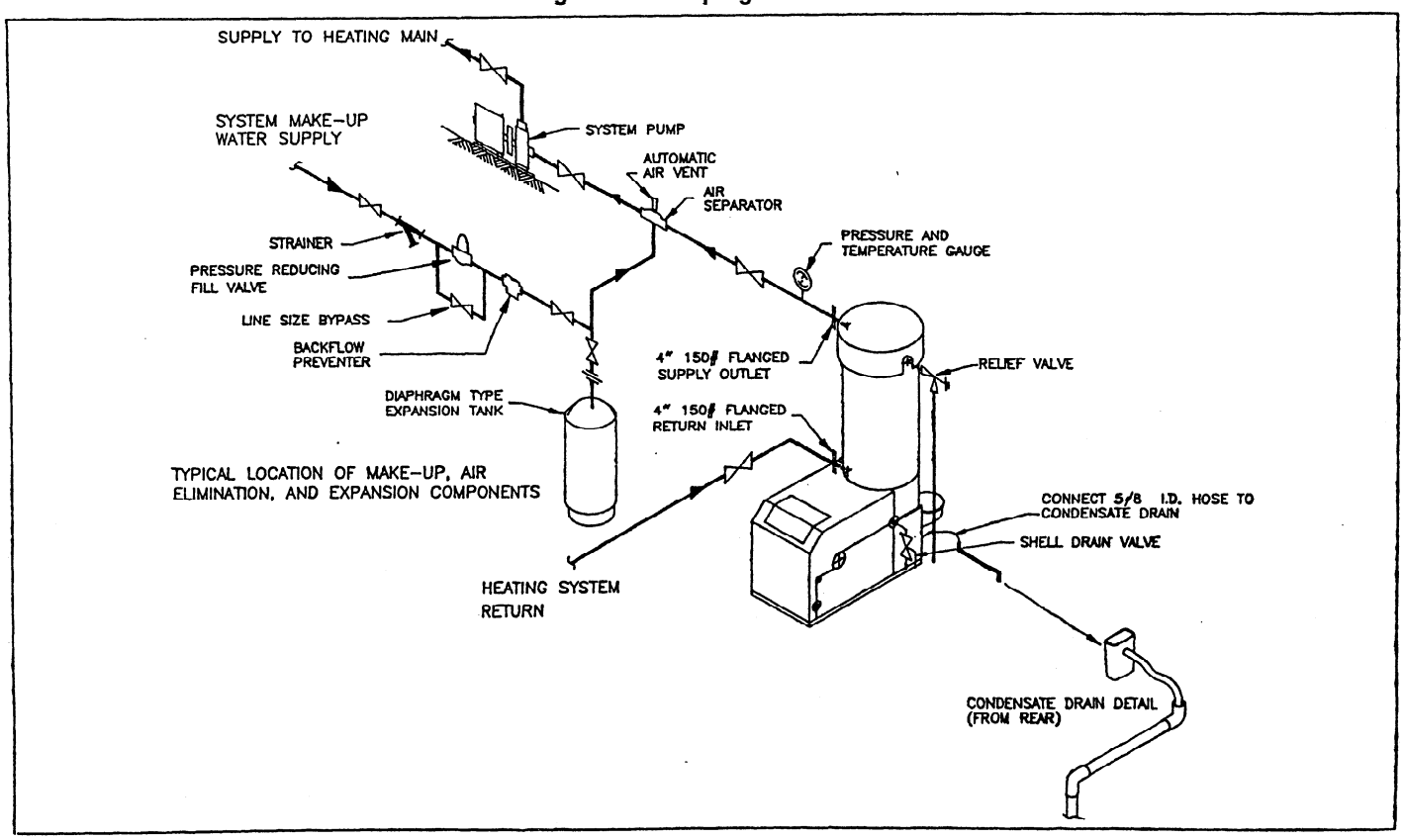
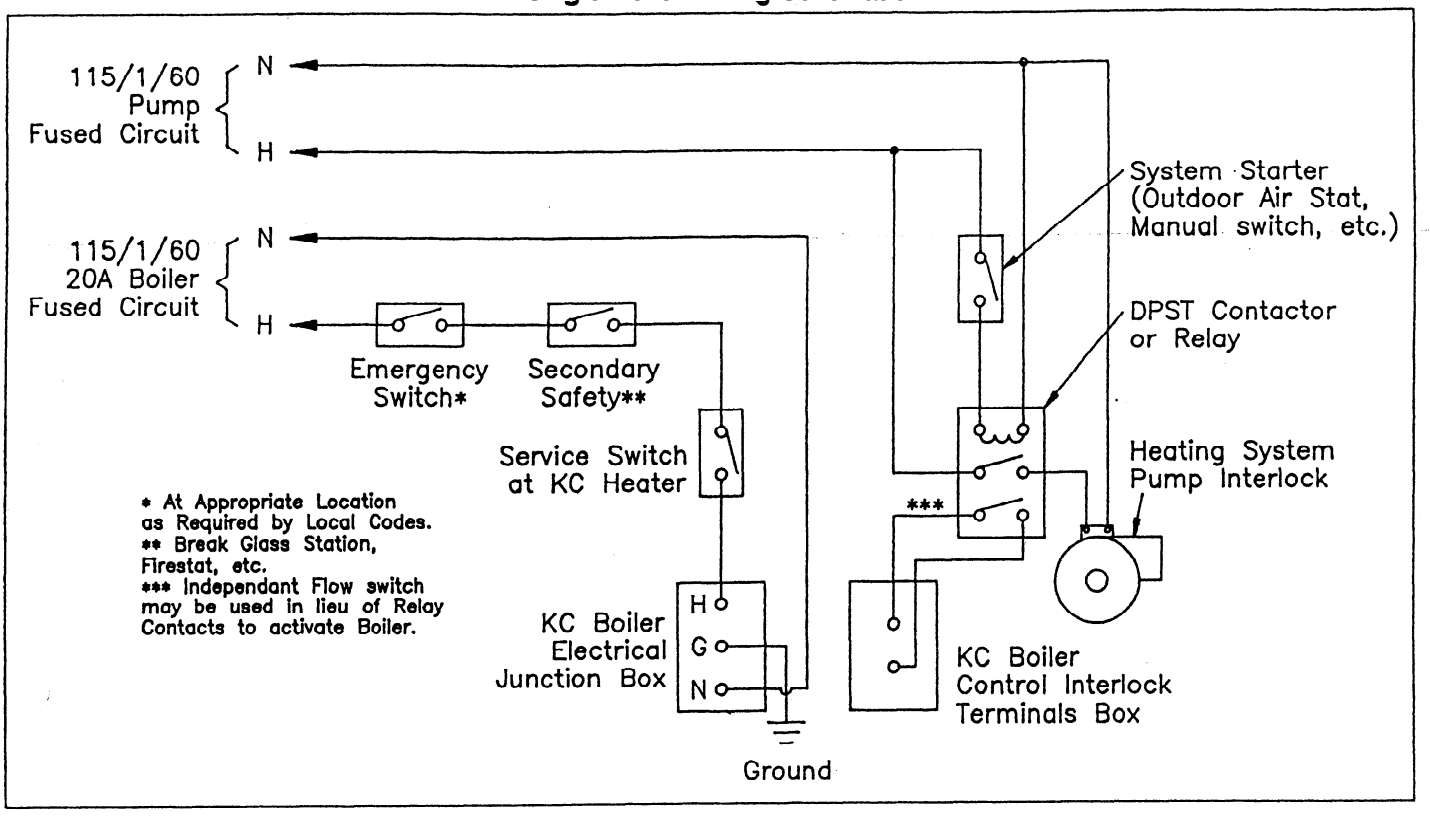


Diagram 3
Single Boiler Wiring Schematic



The circulating pump for the system should be started with the KC unit and should be constant run. If intermittent pump operation is desired (such as with multiple zones), a flow switch or other method should be used to prevent the KC unit from firing under no flow. A unit energized to fire with insufficient or no flow will trip out on high temperature limit.

Once activated, the internal boiler temperature controls will modulate the input of the boiler to match the control algorithm set. Shown is a typical indoor/outdoor reset mode. The temperature of the boiler water to the system will increase as the outdoor temperature decreases. The rate of change can be varied by the adjustable reset ratio on the boiler control panel. If ordered with an internal setpoint control system, the temperature of the boiler water to the system will remain constant to the system at any adjustable setpoint from 50F to 220F.

2. Four Module Boiler-Heating Only

KC modular boiler plants are the ultimate energy conversion for building space heating. By modulating input at extremely high combustion efficiency, there is no wasted energy from overshoot. A KC Modular plant offers inherent standby protection and ease of installation along with longevity. Boiler plants from two to eight modules can be controlled from a single Model 168 Boiler Management System. Boilers can be arranged in back-to-back or inline piping applications as space permits. Boiler plants should be laid out with appropriate space for normal maintenance and operation.

Sequence of Operation

In a modular boiler plant of over two modules, the use of a Model 168 BMS system is mandatory. The BMS system has an Internal Plant Start adjustment that can be set from 32F to 100F outdoor air temperature. When the boiler plant is activated, the system pump should be started simultaneously. This can be controlled from outside the BMS, but boilers that fire with no flow will trip out on internal over temperature controls.

Once activated, the BMS will stage on the first module and increase the module input to increase header temperature. The first module will increase input as required until a preset adjustable percentage of input, normally 60-70%, is reached. At that point, the BMS will start a second module and decrease input on the first unit to equal the inputs. The two modules will continue to increase discharge temperature as required by the BMS. At the point where the two firing modules reach the transfer percentage point, the BMS will start a third module and equalize all module inputs to minimize temperature fluctuation. As the demand setpoint increases, the BMS will stage the fourth module on at the start *Transfer Setpoint,* and bring input on all modules up as needed.

Module inputs will modulate down in response to the BMS in a reverse manner. The module will come off line at the transfer setpoint to maximize condensing. Whether the BMS is set in a Constant Temperature or Modulating Temperature mode, it will use the modulating ability to prevent header temperature fluctuation and maximize efficiency. As well, the BMS can stage auxiliary equipment such as combustion air dampers and fans. Refer to Product Spec BMS-1 for details.

Diagram 4
Multiple Boiler Piping Schematic

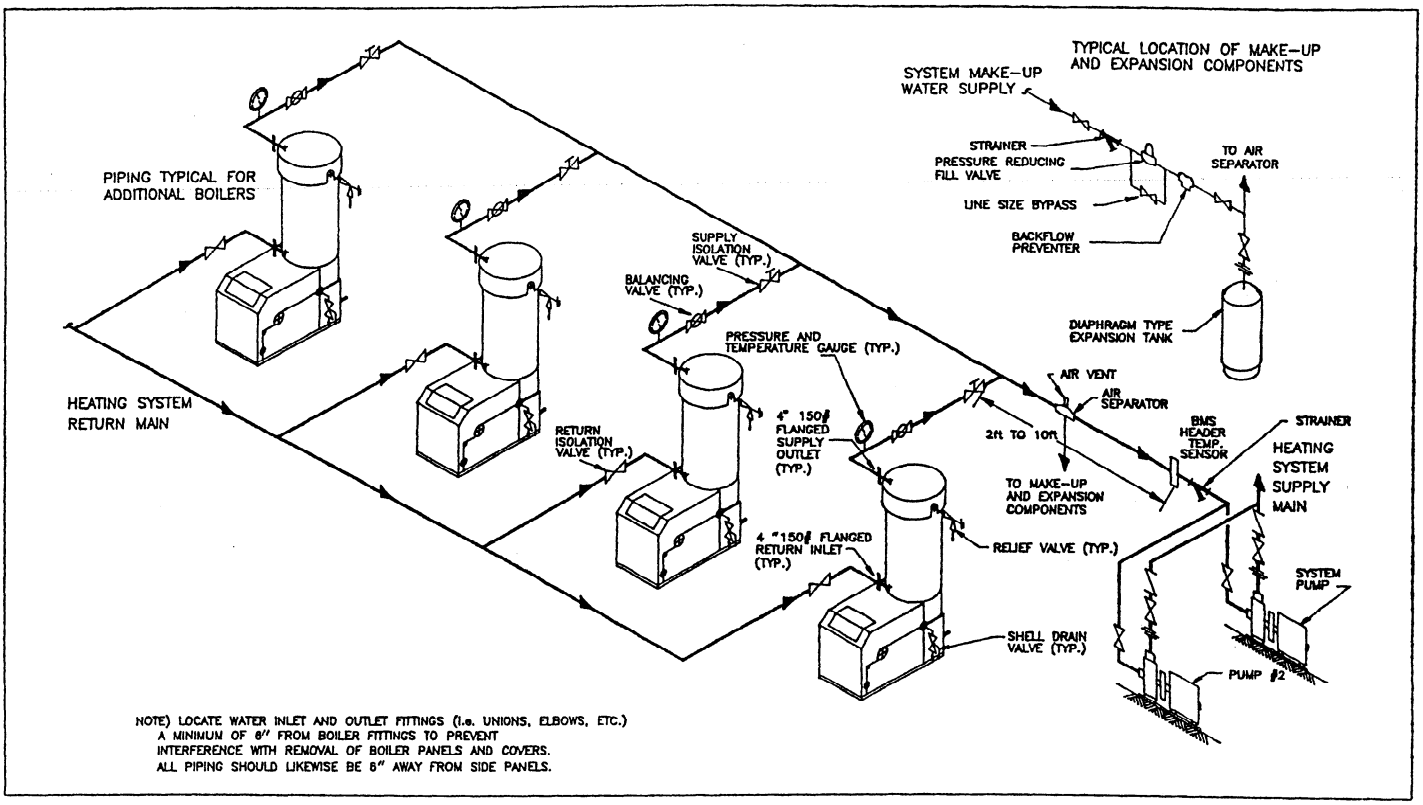
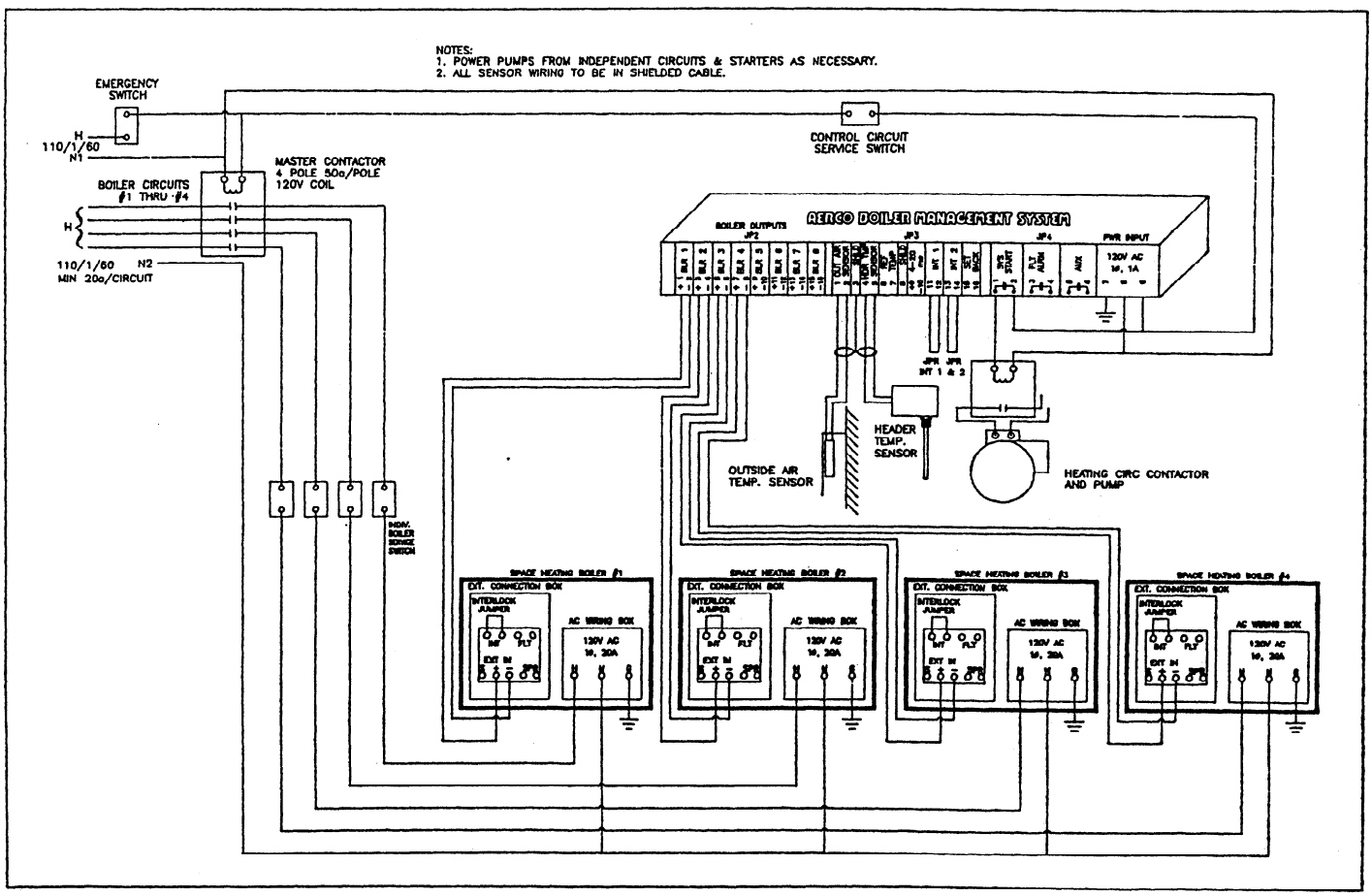


Diagram 5
Four Module Heating Plant
External Reset (I/O) Mode



3. Two Module Boiler-Water Source Heat Pump Application

Sequence of Operation

In Water Source Heat Pump systems, the function of the units is to supplement the loop to maintain a constant temperature. This temperature range (65F to 90F) is too low for conventional fossil fuel boilers because condensation will form in the firesides causing corrosion. AERCO KC units are built to withstand condensation and excel in this type of application because the low return water temperature maximizes the condensing capability of the units.

Normally the boiler plant is activated from the Main Heat Pump Control/Sequence Panel when the system requires auxiliary heat. Once activated, the boiler modules will modulate independently to maintain the loop temperature. Extremely close tolerances to temperature setpoint will be maintained:

Diagram 6
Two Module Water Source Heat Pump Piping

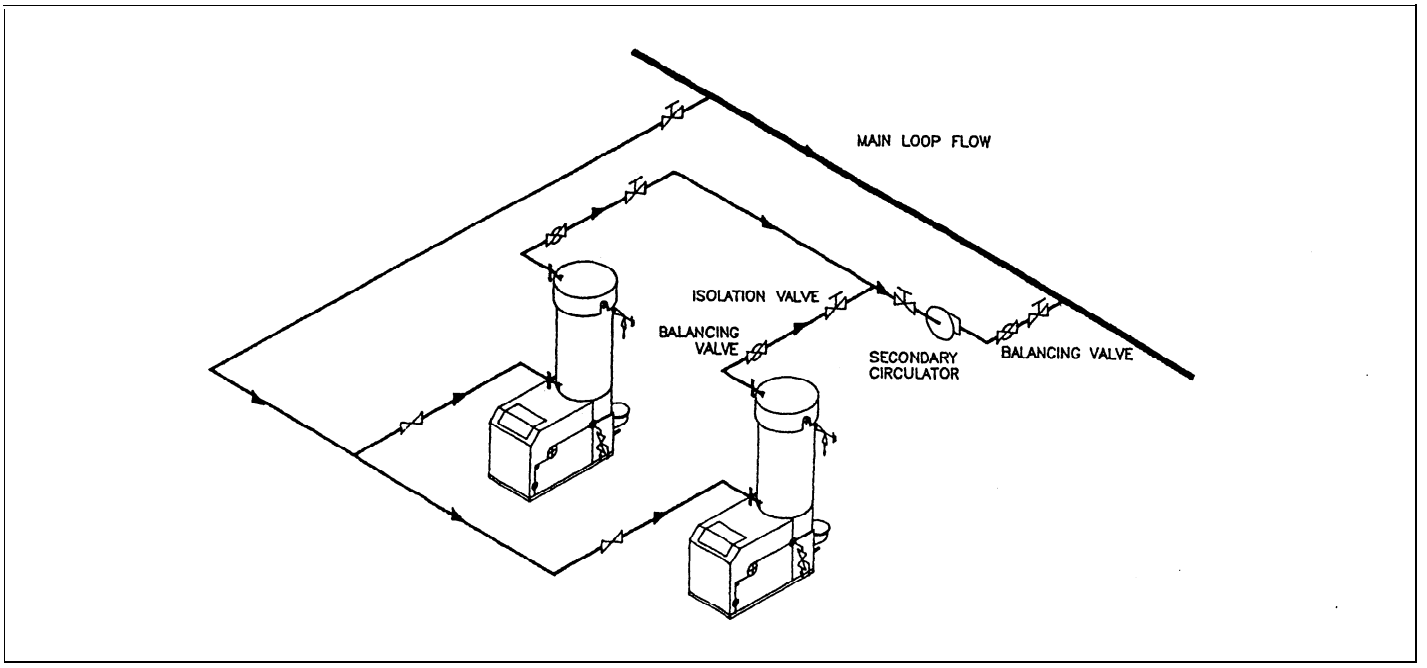
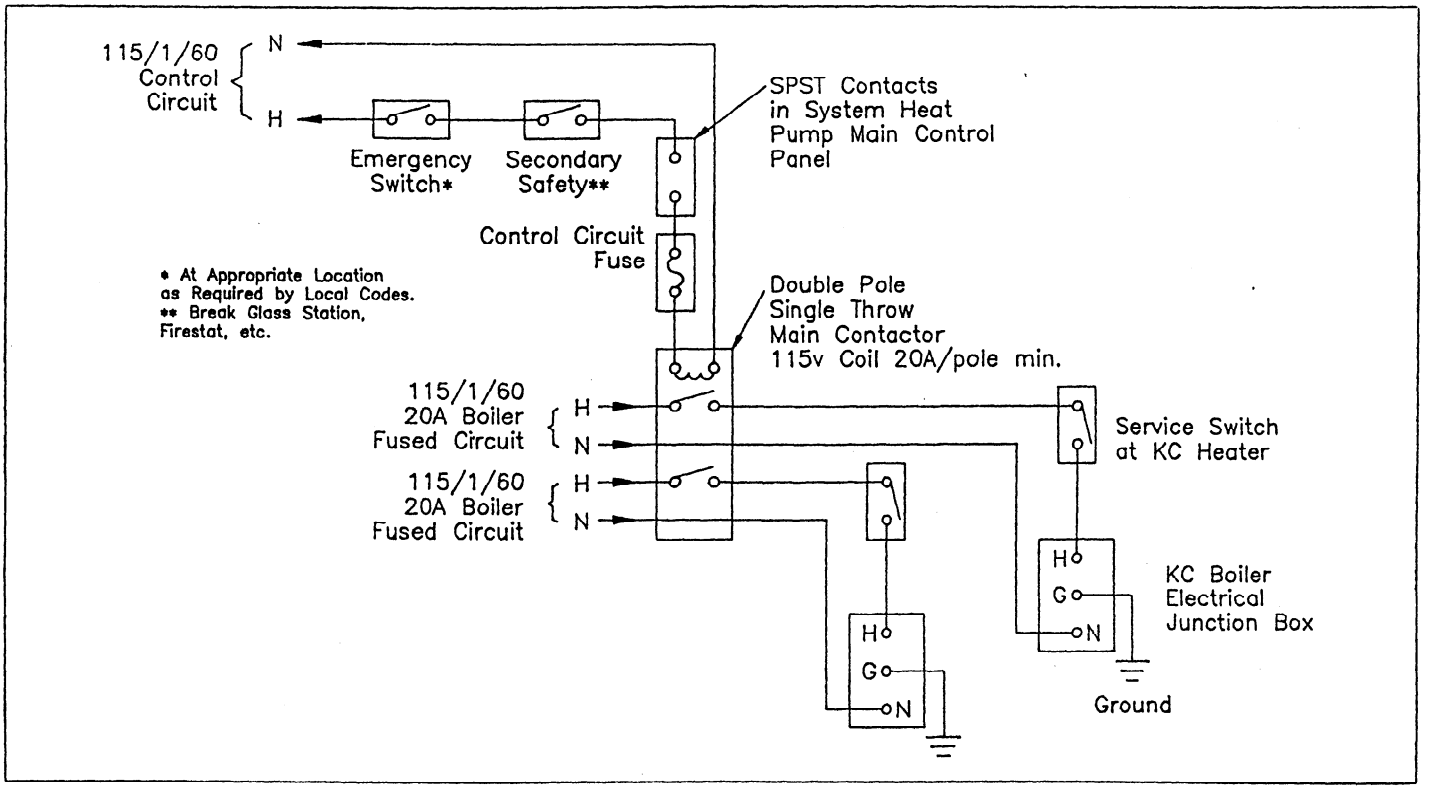


Diagram 7
Water Source Heat Pump Wiring Schematic



4. Three Modules-Combination 2/1 Combination System

It is best to specify and install separate heating and domestic water systems wherever possible. However a combination heating and domestic hot water plant can be specified to share the loads among common boiler modules. The domestic water must be generated in an external hot water storage generator (a storage tank with water-to-water exchanger). This type of system is not applicable to instantaneous or semi-instantaneous systems. The heating load should be developed from ASHRAE or industry standard methods, and the domestic water load should be sized with conventional sizing criteria.

If the design is for a replacement system, the size of the storage tank is fixed and sufficient recovery most be provided. If a new application, the tank storage should be sized large enough to prevent the boiler(s) from short cycling under low loads. Diagram 8 illustrates proper piping for an Aerco KC Combination plant.

The heating only boilers should be specified with BMS control option and the boilers for domestic water should be specified with combination control option (Order Code 6). The boilers must be piped with a balanced flow piping arrangement. A two-position, two-way valve with end switch must be installed in the supply piping to isolate the domestic water modules from the heating system. An AERCO Model 168 BMS system and **a** Model CCP Combination Control Panel must be used as an operating control regardless of plant size in a combo plant configuration.

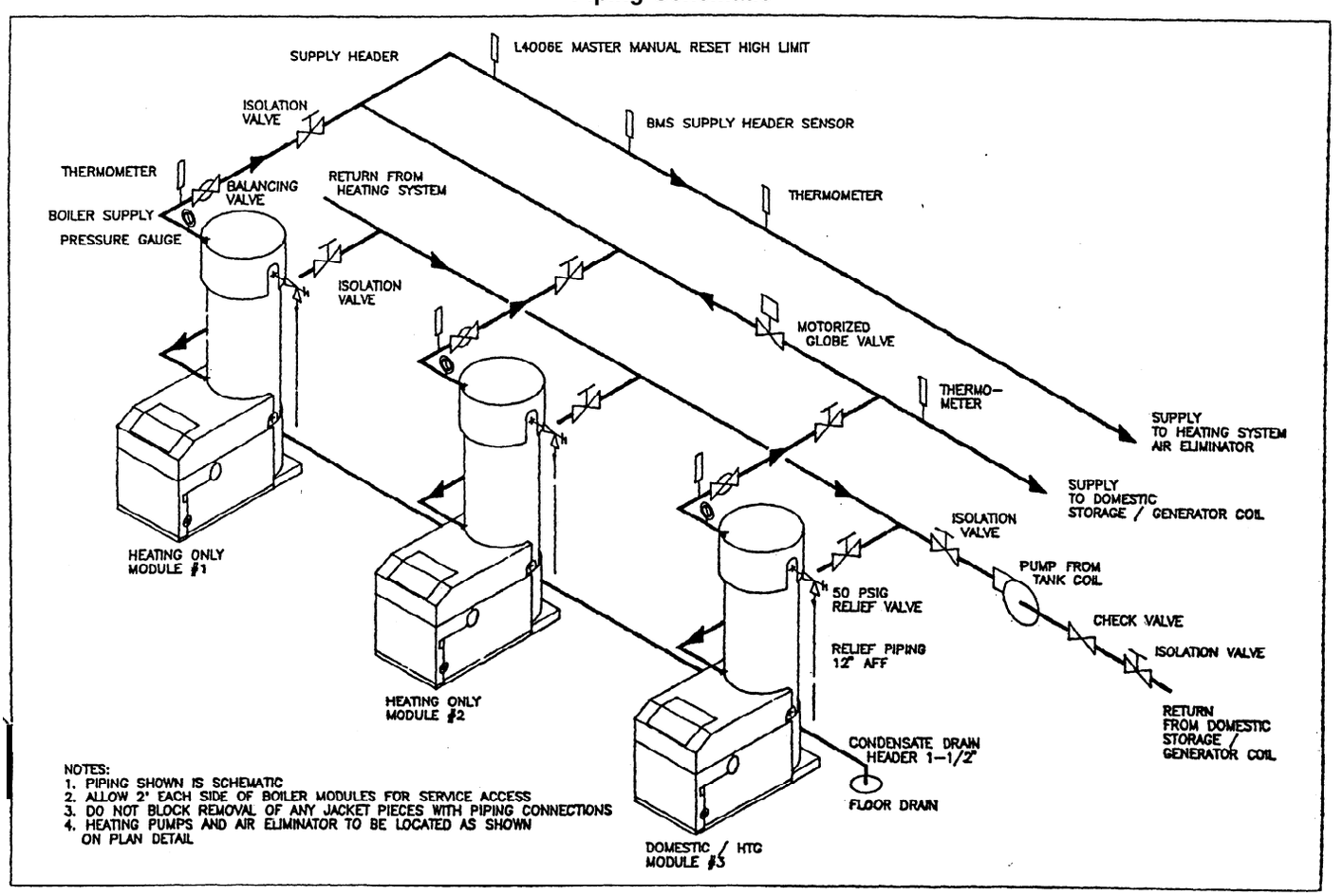
The Aerco Model CCP Combination Control Panel is an accessory partner to the Model 168 BMS for properly handling both domestic heating and space heating with KC series units. The CCP can handle from 1 to 4 boilers. isolated from the heating plant to produce constant temperature water to a separate domestic exchanger. The constant setpoint of the boilers is field adjustable. The CCP also provides control of the motorized isolation valve, domestic water priority, and transfer of the boilers to the BMS when required by space heating needs. The domestic water exchanger circulating pump is also controlled from the CCP Panel.

A circulating pump between the domestic modules and the external hot water generator is also required. The auxiliary circulating pump should be selected for the required gpm and dynamic head losses of the isolated coil circuit.

Sequence of Operation

On a year round basis, the Domestic Tank Aquastat is set for the desired domestic water tank temperature. As tank temperature drops, the aquastat closes. The CCP will then activate the starting coil of the circulating pump between the domestic modules and the tank exchanger

Diagram 8
Three Module Combination Heating /Domestic Water Piping Schematic



coil. The CCP also closes the control interlock on domestic water modules, allowing them to modulate up to a constant temperature (design water temperature for domestic tank coil). The modules fire and circulating pump will continue to operate until tank temperature is satisfied.

As the heating season starts and outdoor air temperature drops, the BMS internal system start will activate central heating system pumps through internal relay contacts. The-Model 168 BMS will modulate and stage the heating only modules on at the adjustable transfer setpoint in *Bumpless Energy Transfer* logic as setpoint demands (normally 60-70%). The Model BMS 168 can operate in any of the normal programmable operating modes in a combination system (Constant Temp, I/O Reset, or 4-20ma signal). For example, when BMS is operating in external reset mode (I/O), required header setpoint will raise as outdoor air temperature drops.

The BMS will continually monitor heating header supply water temperature. When the BMS has all heating-only modules firing at 100% input, the CCP will open the two-way valve in the supply piping to allow the domestic modules to be added to the heating system. The heating boiler(s), in response to the additional energy added by the domestic boiler (s), will modulate. down to maintain header temperature. If the domestic system requires heat, priority is given to the domestic load. The CCP will close the two-way valve, allowing the domestic boiler(s) to supply the exchanger coil. The two-way valve will be closed by the CCP when the boiler plant has modulated down below the auxiliary contact drop-out setpoint.

Diagram 9
Combination Heating & Domestic
Water Heating Schematic External Reset Mode