General

AERCO KC Series gas fired potable water heaters and boilers are modulating input devices that require an adequate volume and pressure of gas for proper operation. Whether natural gas or propane, the gas requirements of the equipment must be properly met to fire reliably. Designers and installers must adhere to the recommendations of AERCO and of the local authorities having jurisdiction. A thorough understanding and knowledge of these recommendations is required for a successful design and installation.

Gas Train Components

AERCO heaters come with a standard UL/FM approved gas train, factory tested and fired, with a minimum number of modular components. These components have been designed to operate at extremely high combustion and seasonal efficiencies by closely controlling both the volume and air / gas mixture to the burner. The major internal gas train components are:

- SAFETY SHUT OFF VALVE (SSOV)-an electro-hydraulic double seated gas valve, containing proof of closure switch, is utilized to stop fuel from flowing into the gas train of the heater. This is a 100% tight shutoff device that has a visible window indicator of valve position. Reliable and a standard industry component, this valve is factory piped with a gas pressure switch on the inlet side of the valve. The gas pressure switch monitors the manifold pressure for minimum supply conditions.

- GAS DIFFERENTIAL REGULATOR-a self-contained diaphragm type regulator is used to maintain a constant gas pressure differential across the air /fuel valve. This regulator, adjusted at startup only, is key to the proper, stable operation of the heater.

- AIR/FUEL VALVE-controls both volume and proper air/gas mixture to the burner through two separate valve body /seat portions within a single housing and with a common shaft. The gas portion of the valve is a slide port type valve with linear proportion-to-position characteristics. The aluminum valve body and machined gas plug are closely matched to allow precise gas flow as the ports of the seat are opened or closed. The driver of the valve is a precision stepping motor at the top of the shaft providing continuous positioning from full input to minimum fire. The operation of the valve controls the volume and mixture of air and fuel in perfect proportion throughout the entire modulation from minimum to maximum. The air/fuel valve also contains two proof of position switches.

- NOZZLE-MIX BURNER-provides the actual point of air/fuel contact and combustion into the cylindrical combustion /heat exchanger. Fabricated from stainless steel and Inconel, the burner is stable throughout the input range of the heater, and holds both the spark ignitor and flame rod for the combustion supervision system. Easily removable from the heater, the burner porting and vane design bring the air and fuel together with high velocities for precise mixing and controlled combustion.

Gas Pressure Requirements

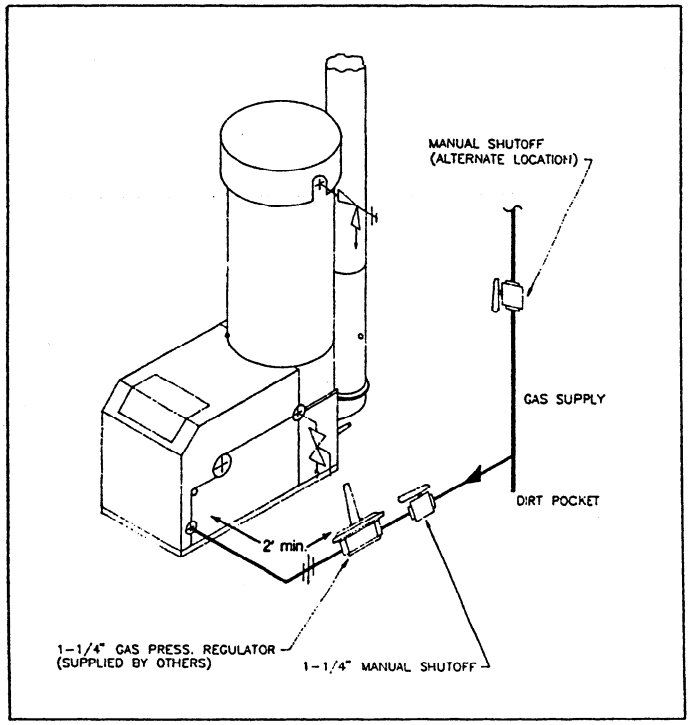
Though it is a modulating burner, every AERCO KC Series heater requires a stable pressure. For natural gas or propane, the inlet supply to the heater *must be 8.5" W.C. min. when firing at maximum input.* A Minimum Supply Gas Pressure Switch in each manifold prevents the heater from operating without sufficient pressure. Maximum gas pressure for natural gas and propane heaters is 14" W.C. Static gas pressure (when the units are not firing) may vary, but actual gas pressure should be measured when the unit is in operation with a manometer at the 1/8" NPT port provided in the inlet manifold. In a multiple heater installation, gas pressure should initially be set for a single heater in operation, and then additional heaters should be staged on, to be certain gas pressures do not droop more than 1" W.C., but never below the minimum allowable pressure. Low gas pressures must be adjusted for proper operation. A fluctuating gas pressure can be indicative of either faulty fuel supply regulator operation or undersized gas supply piping.

An external pressure regulator should be installed on each KC heater. The *regulator must be installed with no* less *than 2 feet of pipe between the regulator and heater gas inlet.* Regulator discharge range must be able to maintain 8.5" W.C. for natural gas or propane. For gas supply pressures exceeding 14" W.C., a lockup type regulator is required. Gas regulators are self-contained with diaphragm vent holes to allow diaphragms to change position. These vents normally require escape piping to the outside from the heater location. The differential pressure regulator in the gas train is factory piped and does not require any vent piping.

Individual Heater Supply Gas Lines

Every heater is factory supplied with a 1-1 /4" NPT plug type gas cock intended to be installed close to the Gas Train inlet for use as a service valve. It also provides a positive shut-off to be used during gas pipe testing to isolate the heater. This cock may be installed on either vertical or horizontal piping into the heater. Refer to Diagram 1 for typical location of the gas shutoff to each heater. Gas piping should contain ground unions for removal of the gas piping to the heater for maintenance or service as required. Gas piping should never obstruct the removal of the side panels of the heater, and should not be supported from the heater itself. Gas piping should be supported properly from the floor or overhead as the installation allows.

Diagram 1
Typical Pipe Connection to an Individual Heater



Drip legs are recommended on each heater to prevent any dirt, pipe chips, or debris from entering the heater Gas Train Inlet. When multiple heaters are installed, some utilities and local codes require a full size dirt leg on the gas main' as well as on the individual units. The bottom of the gas drip leg should be removable without disassembling gas piping. The weight of the gas pipe should not be supported from the bottom of the drip leg.

Custom Gas Trains

Some utilities, insurance carriers, and industrial customers have special requirement gas components on high input devices beyond that normally supplied with AERCO KC heaters. Secondary shutoffs, high or low pressure operators, and external regulators are typical of the requirements of gas utilities. It is mandatory that a designer or installer comply with these requirements. AERCO assumes no liability when these requirements are not satisfied for any location or installation. Contact your local gas utility for their specific requirements before installing AERCO equipment. Special gas trains for IRI and other standards are available. Please contact the AERCO factory with your specific requirements during design.

Gas Piping

All gas piping and components must comply with NFPA local codes, and utility requirement's minimum. Only gas approved fittings, valves, or pipe should be utilized. Standard industry practice for gas piping is Schedule 40 iron pipe and fittings. All high and low gas pressure piping systems must comply with local utility and building codes.

Assembled piping should be clean of all debris, pipe chips, or foreign material to prevent any from entering the KC Series heater gas train. Piping should be tested as prescribed in NFPA. Equipment should be isolated before testing any piping system over the allowable pressure. *DO NOT EXCEED 1/2 PSIG* on the inlet side of the KC Heater at any time.

Gas Supply Main Sizing

Gas pipe sizing, for either a single or multiple heater installation, shall be sized to provide no more than a 0.3" W.C. drop from the source to the heater location. The fuel supplier or utility should be consulted to confirm that sufficient volume and normal pressure is provided to the building at the discharge side of the gas meter or supply pipe. For existing installations with gas equipment, gas pressure should be measured with a manometer to be certain sufficient pressure is available. Before sizing gas piping, a survey of all connected gas devices should be made. Gas piping supplying more than one gas device must be able to handle the total connected input within the allowable gas pressure drop. As well, the allowable minimum and maximum gas pressure for each device should be considered. Whenever the minimum and maximum gas pressures vary between devices, gas pressure regulators at each unit should be installed to allow regulation at any individual unit. Gas pressure must never exceed the maximum allowable of any connected device.

The total length of gas piping as well as fitting pressure drop should be considered when sizing gas piping. Total equivalent length should be calculated from the meter or source location to the last heater connected. Gas piping tables 6.1, 6.2, 6.3, 6.4 from NFPA 54 should be used as a *minimum.* (See Tables pages 3 and 4.) Gas pipe should be selected on a total equivalent length from the appropriate table. The gas volume for cfh flow will be the input divided by the calorific value of the fuel to be supplied.

Gas Header Sizing

Main supply gas pipe sizing should be developed for the total plant. Heater gas manifold piping should be sized based on the volume requirements and lengths between heaters and the fuel main. Multiple heater manifold sizing (Diagram 2) indicates the proper sizing for units placed on the factory standard 50" centers with 1-¼" takeoffs for each unit. Header sizes can be either full size or stepped in size as units are connected. A typical gas piping header diagram for a 5-Module KC Heater Plant is illustrated in Diagram 3.

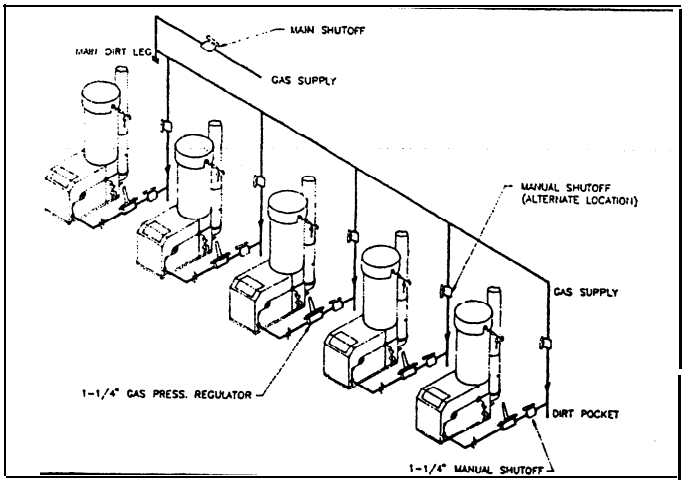
Diagram 2
Multiple Heater Manifold Chart

KC SERIES HEATER GAS HEADER SIZING								
No. of Heaters	1	2	3	4	5	6	7	8
Schedule 40 Iron Pipe*	1¼"	2"	3"	4"	4"	4"	6"	6"

*Based on Natural Gas .60 specific gravity, 1000 BTU /Ft^3
Propane Gas 1.6 specific gravity, 2520 BTU /Ft^3

A single header gas manifold regulator should not be used. Each KC Series heater should have its own individual regulator. Header should be located above or behind heaters. Gas piping should not be installed directly over top or front of any part of heater. Clearances for maintenance are required.

Diagram 3
Typical Multiple Heater Manifold Construction



Gas Piping Tables

The following pipe and vent sizing tables have been taken from the National Fire Protection Association Article 54 (NFPA 54), 1984.

TABLE 6.1

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 Psig or Less and a Pressure Drop of 0.3 inch Water Column

(Based on a 0.60 Specific Gravity Gas)

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Length of Pipe, Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1¼	1.380	1050	—	—	—	—	—	—	—	—	—	—	—	—	—
1½	1.610	1600	1100	—	—	—	—	—	—	—	—	—	—	—	—
2	2.067	3050	2100	1650	1450	1270	1150	1050	—	—	—	—	—	—	—
2½	2.469	4800	3300	2700	2300	2000	1850	1700	1600	1500	1400	1250	1130	1050	—
3	3.068	8500	5900	4700	4100	3600	3250	3000	2800	2600	2500	2200	2000	1850	1700
4	4.026	17500	12000	9700	8300	7400	6800	6200	5800	5400	5100	4500	4100	3800	3500

TABLE 6.2

Pipe Sizing Table for Pressures Under 1 Pound Approximate Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour With Pressure Drop of 0.3 Inch Water Column and 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet							
		50	100	150	200	250	300	400	500
2.00	2.067	1275	—	—	—	—	—	—	—
2.50	2.469	2033	1397	1122	—	—	—	—	—
3.00	3.068	3594	2470	1983	1698	1505	1363	1167	1034
3.50	3.548	5262	3616	2904	2485	2203	1996	1708	1514
4.00	4.026	7330	5038	4046	3462	3069	2780	2380	2109
5.00	5.047	13261	9114	7319	6264	5552	5030	4305	3816
6.00	6.065	21472	14758	11851	10143	8990	8145	6971	6178

TABLE 6.3

Pipe Sizing Table for 5 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 5.0 Psig With a 10 Percent Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe in Feet										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.25	1.380	4084	2807	2254	1929	1710	1549	1326	1175	—	—	—
1.50	1.610	6120	4206	3378	2891	2562	2321	1987	1761	1210	—	—
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391	2331	1872	1602
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405	3715	2983	2553
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556	6568	5274	4514
3.50	3.548	48623	33418	26836	22968	20356	18444	15786	13991	9616	7722	6609
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490	13396	10757	9207
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261	24235	19461	16656
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095	39241	31512	26970

TABLE 6.4

Fitting Equivalent Length Pressure Drop in Feet

Nominal Pipe Size, Inches	Screwed Fittings				90° Welding Elbows		Welding Tees		Valves (Screwed, Flanged, or Welded)		
	45°ell	90°ell	180° Close Return Bends	Tees	R/d = 1	R/d = 1½	Forged	Miter	Gate	Globe	Angle
1¼	1.61	3.45	7.66	6.90	1.84	1.38	5.17	6.90	0.81	38.3	19.1
1½	1.88	4.02	8.95	8.04	2.14	1.61	6.04	8.04	0.94	44.7	22.4
2	2.41	5.17	11.5	10.3	2.76	2.07	7.75	10.3	1.21	57.4	28.7
2½	2.88	6.16	13.7	12.3	3.29	2.47	9.25	12.3	1.44	68.5	34.3
3	3.58	7.67	17.1	15.3	4.09	3.07	11.5	15.3	1.79	85.2	42.6
4	4.70	10.1	22.4	20.2	5.37	4.03	15.1	20.2	2.35	112.0	56.0
5	5.88	12.6	28.0	25.2	6.72	5.05	18.9	25.2	2.94	140.0	70.0
6	7.07	15.2	33.8	30.4	8.09	6.07	22.8	30.4	3.54	168.0	84.1

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