

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 specified herein must be satisfied to ensure efficient combustion. Designers and installers must adhere to the specifications of AERCO and of the local authorities having jurisdiction. A thorough understanding and knowledge of these guidelines is required for the successful design and installation of KC Series units..

Gas Train Components

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

- **SAFETY SHUT OFF VALVE (SSOV)** - An electro-hydraulic double seated gas valve, containing a proof of closure switch, is utilized to stop fuel from flowing into the gas train of the unit. This is a 100% tight shutoff device with a visible window indicator of valve position. Reliable, and a standard industry component, this valve is factory piped with a low 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, typically adjusted at startup only, is key to the proper, stable operation of the unit.
- **AIR/FUEL VALVE** - The valve controls the volume and mixture of air and fuel to the burner in perfect proportion throughout the entire modulation range of the unit. The valve utilizes one common shaft to simultaneously vary the gas port area and air volume. The gas portion of the valve is a slide port type valve with linear proportion-to-position characteristics. The air side uses a butterfly type valve for adjusting the air volume. The driver of the valve shaft is a precision stepping motor, which provides continuous positioning from full input to minimum fire. 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 components, the burner is stable throughout the entire input range of the unit. The spark

ignitor and flame detector for the combustion supervision system are part of the burner assembly. The burner porting and vane design bring the air and fuel together, utilizing high velocities for precise mixing and controlled combustion. The burner can be easily removed from the unit. An optional Low NOx Burner is also available. It is fabricated from a metal fiber mesh covering a stainless steel body.

Gas Pressure Requirements

AERCO KC Series units require a stable gas input pressure. For natural gas or propane units with the standard nozzle mix burner, the inlet supply to the unit *must be* 8.5 " W. C. minimum when firing at maximum input. For natural gas units with Low NOx burners, the inlet supply to the unit must be 8.8" W.C. min. when firing at maximum input. For propane units with Low NOx Burners, the inlet gas supply to the unit must be 7.7" W.C. minimum when firing at maximum input. A Minimum supply gas pressure switch in each gas train prevents the boiler from operating without sufficient pressure. Maximum gas pressure for natural gas and propane units is 14" W.C. Static gas pressure (when the unit is not firing) may vary, however actual gas pressure should be measured when the unit is in operation (firing). Measure the gas pressure with a manometer at the 1/8" NPT port provided in the inlet manifold. In a multiple unit installation, gas pressure should initially be set for a single unit in operation. Then, remaining units should be staged on to ensure that gas pressures do not droop more than 1" W.C. and 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 must be installed at each KC Series unit, as shown in Diagram 1. The regulator must be installed with at least 2 feet of pipe between the regulator and the unit gas inlet. The regulator discharge range must be able to maintain 8.5" W.C. for natural gas or propane units with standard nozzle mix burners. For natural gas units with Low NOx burners, the regulator discharge range must be able to maintain 8.8" W.C. For propane units with Low NOx Burners, the regulator discharge range must be able to maintain 7.7" W.C. A lock-up type regulator is required for installations with gas supply pressures exceeding 14" W.C. Gas regulators are self-contained with tapped diaphragm vent ports allowing the diaphragm to change its position. These vents typically require piping to the outside. For details, refer to the paragraph titled "Venting of Gas Supply Regulators" on page 4 of this guide. The differential pressure regulator in the gas train is factory piped and does not require any vent piping.

Every KC Series unit is shipped 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 unit. This gas cock may be installed on either vertical or horizontal piping into the unit. Refer to Diagram 1 for typical location of the gas shut-off to each unit. Gas piping should contain ground unions for removal of the gas piping to the unit for maintenance or service as required. Gas piping should never obstruct removal of the unit side panels and should not be supported from the unit itself. Gas piping should be supported properly from the floor or overhead as the installation allows.

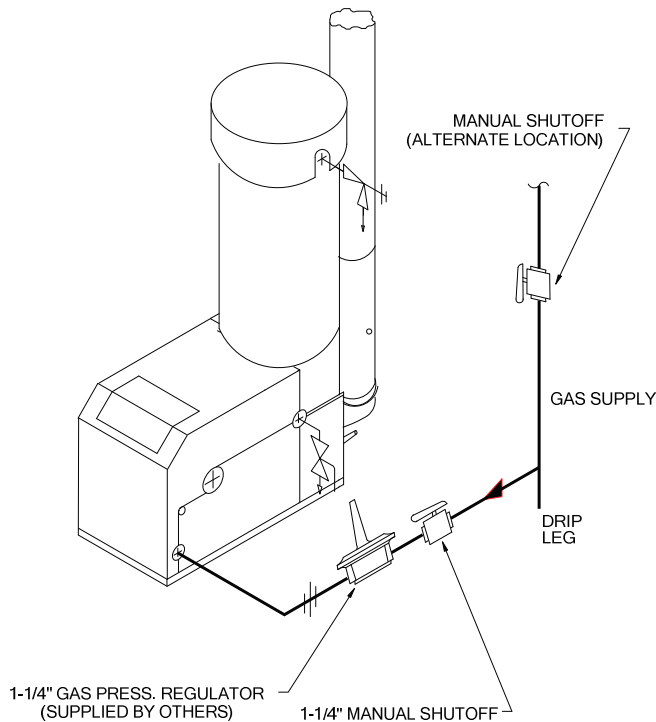


Diagram 1
Typical Pipe Connection to an Individual Unit

Drip legs are typically required at the gas supply of each unit to prevent any dirt, weld slag, or debris from entering the boiler gas train inlet pipe. When multiple units are installed, some utilities and local codes require a full size drip leg on the main gas supply line in addition to the drip leg at each unit. The bottom of the gas drip leg(s) should be removable without disassembling any gas piping. The weight of the gas pipe should not be supported from the bottom of the drip leg. The drip leg(s) should not be used to support any or part of the gas piping.

Custom Gas Trains

Some utilities, insurance carriers, and industrial customers have special requirement gas components on high input devices beyond that which are normally supplied with AERCO KC Series units. 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. IRI gas inlet pressure requirements are as follows:

Design Option

IRI
Low NOx IRI
Low NOx IRI

Inlet Gas Pressure

8.9" W.C. (Natural Gas & Propane)
9.2" W.C. (Natural Gas)
8.1" W.C. (Propane)

Gas Piping

All gas piping and components must comply with NFPA local codes, and utility requirements 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 Benchmark series boiler gas train. Piping should be tested as prescribed in NFPA 54. Equipment should be isolated before testing any piping system over the allowable pressure. **DO NOT EXCEED 14" W. C.** on the inlet side of the KC Series unit at any time.

Gas Supply Main Sizing

Gas pipe sizing, for either a single or multiple unit installation, shall be sized to provide no more than a 0.3" W.C. pressure drop, from the source to the final unit 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 ensure 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. 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 rating of any connected device.

The total length of gas piping as well as fitting pressure drop must be considered when sizing the gas piping. Total equivalent length should be calculated from the meter or source location to the last unit connected. Gas piping Tables 1 thru 4, containing data extracted from NFPA 54, should be used as a *minimum guideline*. Gas pipe size should be selected on the total *equivalent* length from the appropriate pressure table. The gas volume for cfh flow will be the input divided by the calorific value of the fuel to be supplied.

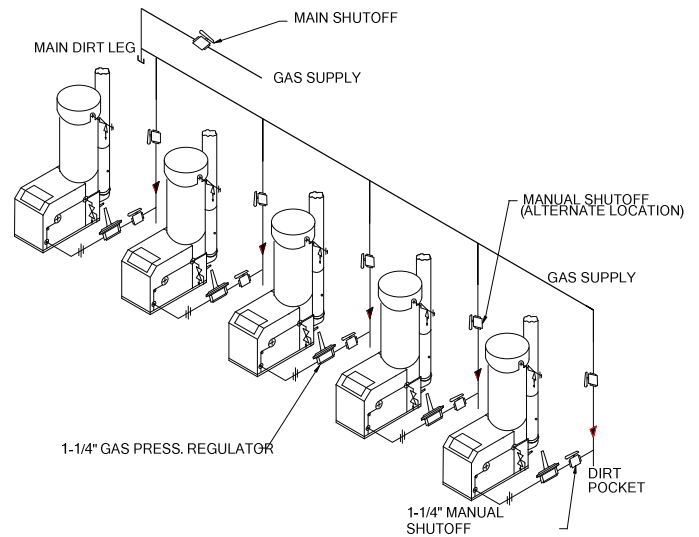
Gas Header Sizing

Main supply gas pipe sizing should be developed for the total plant. Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main. Multiple boiler manifold sizing (Diagram 2) indicates the proper sizing for units placed on the factory standard 52" centers with 2" 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 - Unit Plant is illustrated in Diagram 3.

No. of Units	1	2	3	4	5	6	7	8
Sch 40 Iron Pipe*	1 1/4"	2"	3"	4"	4"	4"	6"	6"

* Based on Natural Gas .60 specific gravity, 1000 BTU/Ft³
Propane Gas 1.6 specific gravity, 2520 BTU/Ft³

Diagram 2. Multiple Unit Manifold Chart



**Diagram 3
Typical Multiple Unit Manifold Construction**

Gas Piping Tables

The data in the following pipe and vent sizing tables have been extracted from the National Fire Protection Association Article 54 (NFPA 54)

TABLE 1

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

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)														
		10	20	30	40	50	60	70	80	90	100	125	150	175	200	
1.25	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210	
1.50	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320	
2.00	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610	
2.50	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	
3.00	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	
4.00	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 2

Pipe Sizing Table for 1 Pound Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 1.0 psi with a 10% Pressure Drop and a Gas of 6.0 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.25	1.380	1471	1011	812	695	616	558	478	423	291	234	200
1.50	1.610	2204	1515	1217	1041	923	836	716	634	436	350	300
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222	840	674	577
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947	1338	1075	920
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442	2366	1900	1626
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039	3464	2781	2381
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020	4825	3875	3316
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701	8729	7010	6000
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566	14135	11351	9715

TABLE 3

Pipe Sizing Table for 2 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 2.0 psi with a 10% Pressure Drop and a Gas of 6.0 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.25	1.380	2283	1569	1260	1079	956	866	741	657	452	363	310
1.50	1.610	3421	2351	1888	1616	1432	1298	1111	984	677	543	465
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896	1303	1046	896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022	2077	1668	1427
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342	3671	2948	2523
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821	5375	4317	3694
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895	7488	6013	5147
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711	13547	10879	9311
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917	21936	17616	15077

TABLE 4

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 psi with a 10% Pressure Drop and a Gas of 6.0 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.25	1.380	4084	2807	2254	1929	1710	1549	1326	1175	808	649	555
1.50	1.610	6120	4206	3378	2891	2562	2321	1987	1761	1210	972	832
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	20365	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

Venting of Gas Supply Regulators

AERCO's general guidelines for venting of gas regulators are listed below. AERCO recommends that these guidelines be followed to ensure the most reliable and proper operation of AERCO gas fired equipment. It is also recommended that you consult local codes and the gas regulator manufacturer for additional details. Always follow the most stringent guidelines available, including those listed below.

- When venting a gas supply regulator, the vent pipe must be no smaller than the regulator vent size.
- In a multiple unit installation, each regulator must have a separate vent line.
- Vent lines must not be manifolded together or with any other equipment at the site that also requires atmospheric vents.

- When sizing the vent, pipe diameters must be increased by one pipe diameter every 20 equivalent feet of pipe.

Each 90° elbow is equivalent to approximately:

- ⇒ 2.5 feet for nominal pipe sizes of up to 3/4"
- ⇒ 4.5 feet for nominal pipe sizes of up to 1-1/2"
- ⇒ 10.5 feet for nominal pipe sizes of up to 4"

Each 45° elbow is equivalent to approximately:

- ⇒ 1 foot for nominal pipe sizes of up to 3/4"
- ⇒ 2 feet for nominal pipe sizes of up to 1-1/2"
- ⇒ 5 feet for nominal pipe sizes of up to 4"

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