

GAS SUPPLY DESIGN GUIDE



**Natural Gas and Propane
Fired, Modulating,
Condensing Water Heater
Models:**

- INN600
- INN800
- INN1060
- INN1350
- Recon 1000

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INNOVATION Gas-Fired Water Heaters



RECON Gas-Fired Water Heaters



Latest revision: 05/05/2016



DISCLAIMER

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1 General

AERCO's Innovation and Recon series gas fired water heaters are modulating input devices that require an adequate volume of natural gas at constant pressure for proper operation. The gas requirements specified in this document must be satisfied to ensure efficient combustion. Designers and installers must adhere to the AERCO specifications and those of the local authorities having jurisdiction. A thorough understanding and knowledge of these guidelines is required for the successful design and installation of Innovation and Recon water heaters.

Please note, Recon Water Heaters are only available in natural gas configurations.

2 Gas Train Components

Innovation and Recon gas-fired water heaters are equipped with a standard UL approved/FM compliant gas trains. These gas trains are factory tested and fired, with a minimum number of modular components. The gas train components have been designed to operate at high combustion 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) With BUILT-IN SUPPLY GAS REGULATOR**
An electro-hydraulic gas valve, containing a 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 with a visible window indicator showing 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 which monitors the manifold pressure for minimum supply conditions. There is also a high gas pressure switch installed on the outlet side of the gas valve, which shuts down the heater if gas manifold pressures exceed maximum conditions. The actuator has a built-in regulator that replaces the need for an external supply regulator for installations that have supply pressure of up to 14.0" W.C. For installations that have supply pressure greater than 14.0" W.C., see the "Gas Pressure Requirements" section.
- **AIR/FUEL VALVE**
The air/fuel valve controls the volume and mixture of air and fuel in perfect proportion throughout the entire modulation range of the heater. 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.
- **CAST ALUMINUM BLOWER ASSEMBLY**
A cast aluminum pre-mix blower ensures the precise mixing of air and fuel prior to entering the burner thereby providing controlled combustion.
- **LOW NOx BURNER**
The burner provides the actual point of air/fuel contact and combustion into the cylindrical combustion/heat exchanger. Fabricated from metal fiber mesh covering a stainless steel body, the burner is stable throughout the entire input range of the heater. The spark igniter and flame detector for the combustion supervision system are part of this assembly. The burner is easily removable from the heater.

3 Gas Pressure Requirements

AERCO Innovation and Recon series heaters require a stable natural gas (all units) and propane (Innovation only) input pressure. The nominal inlet supply pressure to the heater is 7.0" W.C. The allowable natural gas inlet pressure range is 4.0" W.C. (min.) to 14.0" W.C. (max.) when firing at maximum input. For Innovation units, the allowable propane inlet pressure range is 6.0" W.C. (min.) to 14" W.C. (max.) when firing at maximum input. A low supply gas pressure switch in each gas train prevents the heater from operating without sufficient pressure. Maximum allowable gas pressure is 14.0" 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 ball valve provided at the SSOV inlet. In a multiple heater installation, gas pressure should initially be set for single heater operation, and then the remaining heaters should be staged on at full fire, to insure gas pressures never fall below the minimum allowable pressure of 4.0" W.C. for natural gas or 6.0" W.C. for propane.

External Isolation Valve

An external isolation valve must be installed at each Innovation and Recon heater, as shown in Figure 1. This isolation valve is supplied with the heater.

Gas Pressure Regulator

For installations that have greater than 14.0" W.C. supply pressure, an external lock-up type regulator must be installed downstream of the isolation valve. The lock-up type regulator(s) must be sized for at least 1,000 cfh, but no more than 1,200 cfh, per heater. External gas regulators are self-contained with tapped diaphragm vent ports allowing the diaphragm to change its position as required. These vents typically require piping to the outside. For details, see section 6 *Venting of Gas Supply Regulators* in this guide. The SSOV/Regulator in the gas train is factory piped and does not require any vent piping.

The following are AERCO's recommendations for installation of a gas pressure regulator, unless superseded by state and local codes and the regulator manufacturer's specifications:

- Horizontal installation of gas pressure regulators is recommended unless stated otherwise by the regulator manufacturer. Consult the manufacturer for additional recommendations and installation options.
- When installed horizontally the required distance between the gas pressure regulator and the nearest pipe fitting, elbow or valve is 20 inches (see Figure 1).
- When pipe size reduction is required, use only bell reducers.

CAUTION!

THE AERCO HEATERS MUST BE ISOLATED FROM THE SYSTEM WHEN LEAK TESTING.

Drip Legs

Drip legs are typically required at the gas supply of each heater to prevent any dirt, weld slag, or debris from entering the heater gas train inlet pipe. When multiple heaters 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.

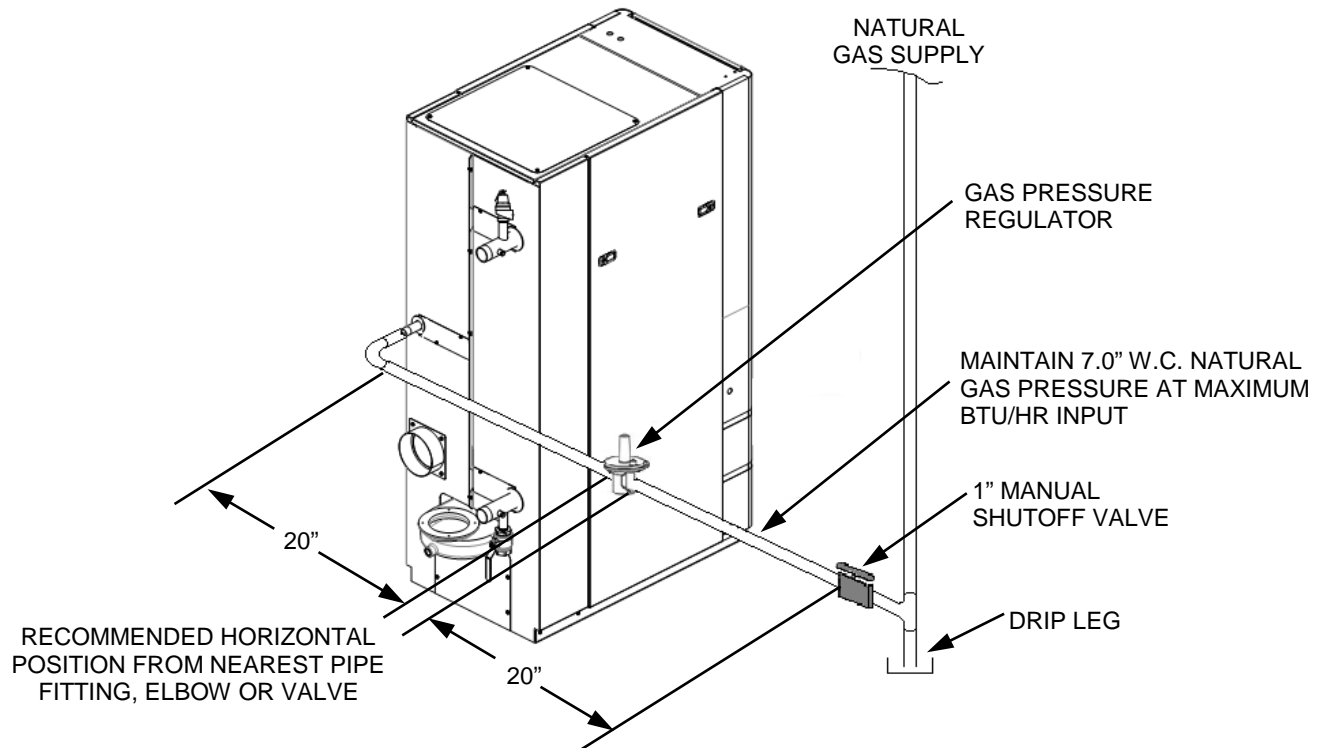


Figure 1: Single Heater Pipe Connections – Innovation Shown

4 Custom Gas Trains

Some utilities, insurance carriers, and industrial customers have special requirement gas components on high input devices beyond what's normally supplied with AERCO 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 with a double block and bleed (DBB) configuration (formerly IRI) are available from AERCO. Gas inlet pressure requirements are as follows:

FUEL	GAS TRAIN	NOMINAL	MINIMUM
Natural Gas	DBB	7.0" W.C.	4.0" W.C.
Propane Gas (Innovation Only)	DBB	7.0" W.C.	6.0" W.C.

5 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 Innovation or Recon water heater 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 14.0" W.C.** on the inlet side of the Innovation or Recon water heater at any time.

5.1 Gas Supply Main Sizing

Gas pipe sizing, for either a single or multiple heater installation, shall be sized for a maximum pressure drop of 0.3" W.C., from the source to the final heater. The maximum gas flow rate required is the sum of the maximum inputs of each unit divided by the heat of combustion of the fuel supplied at the location, (approximately 1,030 BTU per cubic foot for natural gas or 2,520 BTU per cubic foot for propane). 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. 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 heater connected on the header. Gas piping tables 1, 2 and 3 containing data extracted from NFPA 54 should be used as a *minimum guideline*. (See Tables on the following pages). 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.

5.2 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 (Figure 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 3-Module Innovation Heater Plant is illustrated in Diagram 3.

INNOVATION AND RECON GAS HEADER SIZING								
No. of Heaters	1	2	3	4	5	6	7	8
Sch 40 Iron Pipe*	1.5"	3"	3"	4"	4"	5"	5"	5"

Figure 2: Multiple Heater Manifold Chart

* Based on Table 1 on the following page for natural gas, 0.6 specific gravity, 1,000 cfh/unit, actual header sizes will vary with length of pipe run and fittings employed. For propane gas (1.6 specific gravity, 2,520 BTU/FT³) header sizing, consult NFPA 54.

If supply gas pressure exceeds 14.0" W.C., a single header gas manifold lock-up type regulator, -or- individual lock-up regulators can be used to bring the gas pressure down to 14.0" W.C. Header should be located above or behind heater. Gas piping should not be installed directly over top or front of any part of heater. Sufficient clearances for maintenance are required.

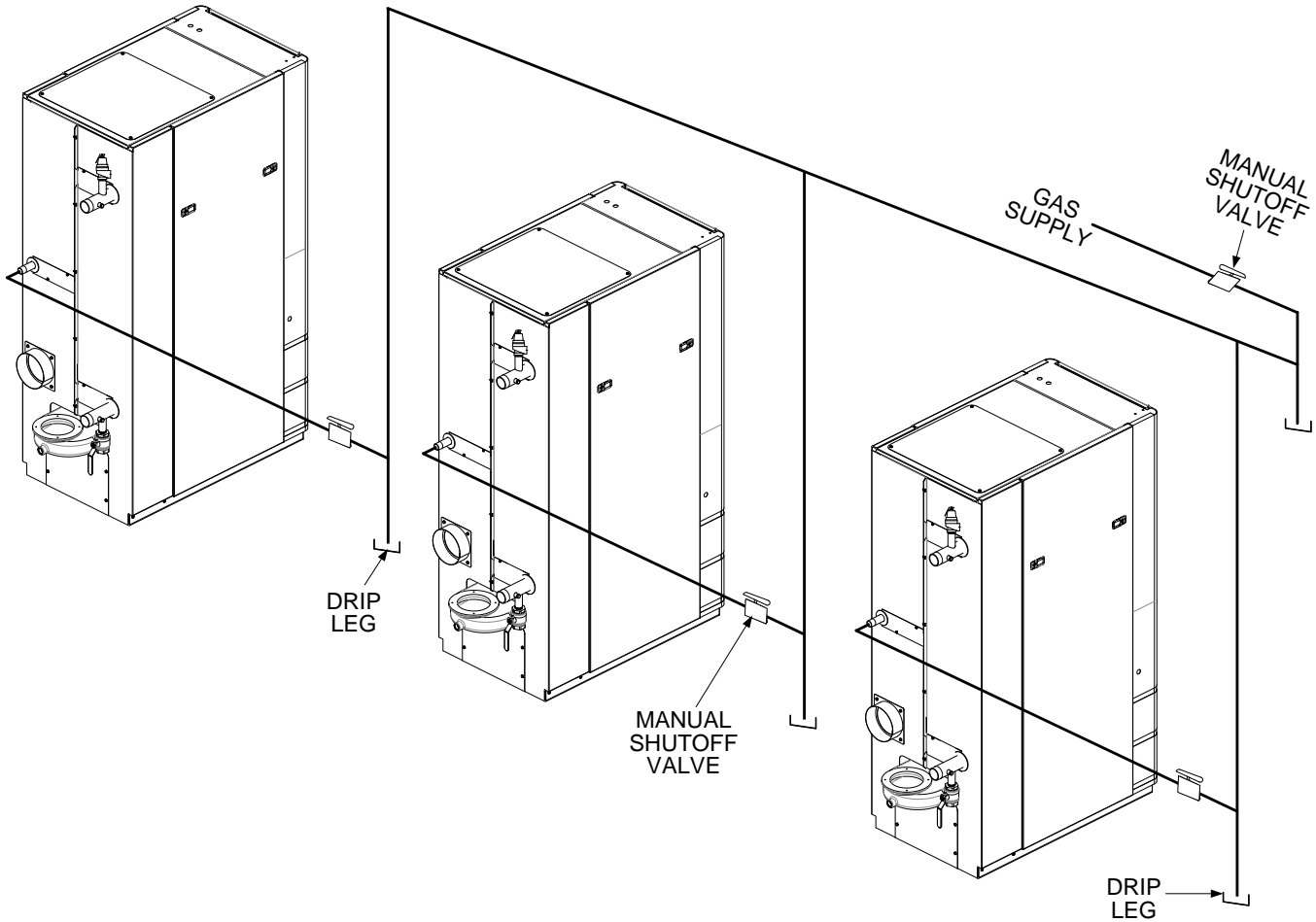


Figure 3: Typical Multiple Heater Manifold Construction

5.3 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	125	150	175	200	
2.00	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	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	1,250	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	2,200	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	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 0.6 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
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566
8.00	7.981	146849	100929	81049	69368	61479	55705	47676	42254

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 0.6 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
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917

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 0.6 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
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556
3.50	3.548	48623	33418	26836	22968	20365	18444	15786	13991
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095

6 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"

Change Log

Date	Description	Changed By
10/14/2014	Rev F PIRs: PIR 1056, 934-101: Changed document name to reflect that this document now applies to Innovation AND Recon products, added outline numbering to section titles	Chris Blair
05/05/2016	Rev G PIRs: 934-186: Remove references to ReCon 500. DIR 345: Added information on locating the gas pressure regulator in section 3.	Chris Blair



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CALCULATION WORKSHEET: PIPE SIZING, BRANCH LENGTH METHOD

Step 1:

- Draw a sketch of the piping system in the space to the right.

Step 2:

- Enter the system information. Note that demand is the amount of gas flowing through a section of pipe.
- Use total Btu/hr rating/1000 (ft³/hr) for natural gas.
- Use total Btu/hr for propane.

Length of runs:
A=
B=
C=
D=
E=

Pipe system sketch

Step 3:

- Determine the gas used and the system pressure, and enter it on the right.
- Determine the piping material and enter it on the right.
- Select the appropriate pipe sizing table, above, and enter it on the right.

Gas: _____

Pressure: _____

Piping Material: _____

Table used: _____

Pressure Drop: _____

Step 4:

- On the sketch above, label the section of pipe from the point of delivery (meter or regulator) to the manifold as Section A.

Table 1: Piping System

Step 5:

- Determine the length of the branch serving each appliance. Enter this length in Table 1.

Section	Demand (chf)	Section Length	Size

Step 6:

- Enter the input rating for each appliance in Table 2. For natural gas appliances, enter the input rating in ft³/hr. For propane appliances, enter the input rating in thousands of Btu/hr.

Step 7:

- From the table, determine the length of each pipe section using the appropriate table, using only the row with the longest length. Round up to the lengths in the table. Read across until a capacity equal to or greater than the required demand for the section is found. Read up to find the size. Repeat for each section of piping. Enter this size in Table 2.

Table 2: Appliances Table

Appliance	Demand	Section Length	Size
TOTAL			

JOB: _____ **PREPARED BY:** _____ **DATE:** _____

The following is an example of a completed worksheet:

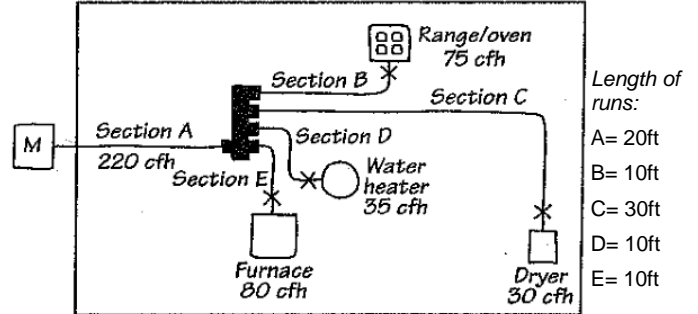
CALCULATION WORKSHEET: PIPE SIZING, BRANCH LENGTH METHOD

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- Use total Btu/hr rating/1000 (ft³/hr) for natural gas.
- Use total Btu/hr for propane.



Pipe system sketch

Step 3:

- Determine the gas used and the system pressure, and enter it on the right.
- Determine the piping material and enter it on the right.
- Select the appropriate pipe sizing table, above, and enter it on the right.

Gas: NATURAL

Pressure: 7in. w.c.

Step 4:

- On the sketch above, label the section of pipe from the point of delivery (meter or regulator) to the manifold as Section A.

Piping Material: Copper

Table used: 6.2 (h)

Pressure Drop: 1.0 in. w.c.

Table 1: Piping System

Step 5:

- Determine the length of the branch serving each appliance. Enter this length in Table 1.

Section	Demand (chf)	Section Length	Size
A	220	50 ft.	1 in.

Step 6:

- Enter the input rating for each appliance in Table 2. For natural gas appliances, enter the input rating in ft³/hr. For propane appliances, enter the input rating in thousands of Btu/hr.

Step 7:

- From the table, determine the length of each pipe section using the appropriate table, using only the row with the longest length. Round up to the lengths in the table. Read across until a capacity equal to or greater than the required demand for the section is found. Read up to find the size. Repeat for each section of piping. Enter this size in Table 2.

Table 2: Appliances Table

Appliance	Demand	Section Length	Size
Furnace	80	30 ft.	1/2 in.
Furnace			
Water Heater	35	30 ft.	3/8 in.
Water Heater			
Range	75	30 ft.	1/2 in.
Oven			
Dryer	30	30 ft.	3/8 in.
Other			
Other			
Other			
TOTAL	220	--	--

JOB: 25 Main St. **PREPARED BY:** TL **DATE:** 6/10/13