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AIR FORCE AFM 88-8, Chap. 5

TECHNICAL MANUAL

NONINDUSTRIAL GAS PIPING SYSTEMS

HEADQUARTERS, DEPARTMENTS OF THE ARMY, AND THE AIR FORCE
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TECHNICAL MANUAL
No. 5-810-6
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No. 88-8, CHAPTER 5

HEADQUARTERS
DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
Washington, DC *30 April 1990*

NONINDUSTRIAL GAS PIPING SYSTEMS

LIST OF FIGURES

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* This manual supersedes TM 5-810-6/AFM 88-8, Chap. 5, 1 Sep 1982.

1. Scope.

This manual includes criteria for the design of component parts and assemblies of fuel gas piping systems for nonindustrial appliances. Compliance with these criteria requires only that fundamental design principles be followed. Materials and practices not prohibited by this manual or its basic references should also be considered. Where special conditions and problems are not specifically covered in this manual, acceptable industry standards will be followed. Modifications or additions to existing systems solely for the purpose of meeting criteria in this manual are not authorized. References used in this manual are listed in the appendix.

2. Purpose.

This manual presents the basic criteria for the design of low pressure (0.5 psig or less) fuel gas piping systems serving nonindustrial type gas appliances. The criteria are based in part on NFPA 54 and ANSI B31.2.

3. Engineering Considerations.

a. The criteria in this manual are applicable to the design of fuel gas piping systems from the point of delivery to the connections with each gas utilization device. The "point of delivery" is defined as the outlet of the customer's meter set assembly (within 5 feet of the building line), or the outlet of the service regulator or service shutoff valve where no meter is provided.

b. The criteria cover the design of piping systems for fuel gases such as natural gas, manufactured gas, liquefied petroleum gas (LPG) air mixtures above the upper combustible limit, LPG in the gaseous phase, or mixtures of these gases. Included are fuel gas piping systems both in buildings and between buildings, and, as applicable, including the first pressure containing valve upstream of a gas utilization device (appliance).

c. Criteria included are limited to the relatively basic but adequate requirements for the conditions normally encountered in fuel gas piping installations. Where problems such as long self-supported spans, unstable ground, mechanical or sonic vibrations, and thermal forces other than seasonal exist, the engineer should design to meet the requirements of ANSI B31.3.

d. Piping systems include components such as pipe, valves, fittings, flanges (except those which are parts of appliances or other apparatus), bolts and gaskets.

4. Conditions.

a. Pressure.

(1) This manual covers low-pressure fuel gas piping systems (systems normally pressurized to 0.5 psig) and, therefore, usually representing a mild condition of coincident pressure and temperature far below the 10 psig working pressure limit for buildings intended for human occupancy. Nevertheless, every piping system designed in accordance with this manual, regardless of anticipated service conditions, will be designed to withstand a pressure of 10 psig between the temperatures of minus 20 degrees F and 250 degrees F.

(2) Piping systems designs will have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or unusual loads at joints, or undesirable forces or moments at connecting points in the system. No formal analyses of thermal expansion and flexibility are required in systems which:

(*a*) Are duplicates of successfully operating installations or are replacements of systems with a satisfactory service load.

(*b*) Can be judged to be adequate by comparison with systems already analyzed.

b. Thrust forces. The forces transmitted to connected appliances or equipment will be kept within safe limits.

5. Piping requirements.

a. Design factors. The factors for ratings, stress values, stress criteria, design allowances and minimum design values used in the design of piping and the permissible variations to these factors should conform to ANSI B31.2.

b. Mechanical strength. When necessary to prevent damage, collapse, or buckling under superimposed loads from supports, backfill or other causes, the pipe wall thickness will be increased. If increasing wall thickness is impractical or would cause excessive local stresses, the adverse factors which would contribute to damage of the pipe will be corrected by other acceptable design practices.

6. Materials and components.

a. Pipe design. Metallic pipe or tubing of nominal wall thicknesses equal to or greater than those listed in table 1 are acceptable for gas piping systems covered by this manual. All underground ferrous gas piping will be cathodically protected. TM 5-811-7 (Army) and MIL-HDBK-1004/10 (Air Force) contain additional guidance pertaining to cathodic protection on underground pipelines. Additions to existing systems will be cathodically protected. Testing stations will be provided in cathodic protection systems.

Table 1. Least nominal wall thickness for pipe and tubing

NOMINAL DIAMETER (INCHES)	STEEL PIPE OR TUBING		COPPER OR ALUMINUM PIPE OR TUBING	
	THREADED OR GROOVED	PLAIN END	THREADED OR GROOVED	PLAIN END
1/8	0.068	0.032	0.062	0.025
3/16		0.032		0.028
1/4	0.088	0.035	0.083	0.030
5/16		0.035		0.035
3/8	0.091	0.035	0.090	0.035
1/2	0.109	0.035	0.107	0.035
5/8		0.035		0.042
3/4	0.113	0.049	0.114	0.045
7/8		0.049		0.049
1	0.133	0.049	0.126	0.049
1-1/4	0.140	0.065	0.146	0.055
1-1/2	0.145	0.065	0.150	0.060
2	0.154	0.065	0.156	0.070
2-1/2	0.203	0.083	0.187	0.080
3	0.216	0.083	0.219	0.090
4	0.237	0.083	0.250	0.110

ADAPTED FROM ANSI B31.2

b. Other components. The criteria for design of pipe bends, branch connections, heads and closures, flanges and reducers are given in ANSI B31.2.

c. Limitations. Copper pipe or tubing will not be used if the gas supplied contains more than an average of 0.3 grains of hydrogen sulfide per 100 cubic feet of gas. Aluminum pipe or tubing will not be used in exterior locations or underground.

d. Use of plastic materials. Plastic pipe may be used only outside underground, or as risers as permitted by Title 49, Code of Federal Regulations, Part 192. Unless expressly excepted for a specific project by the authority having jurisdiction, the use of plastic materials will conform to the criteria established by the AGA "Plastic Pipe Manual for Gas Service"; by Title 49, Code of Federal Regulations, Part 192 (which contains the minimum federal safety standards for the transportation of gas and for pipeline facilities); and by the referenced standards and specifications.

7. Joint selection.

a. Type. The types of piping joints used should be suitable for the pressure-temperature conditions and should be selected giving consideration to joint tightness and mechanical strength under the service conditions. For example, joints must be able to sustain the maximum end force due to internal pressure, i.e., the design pressure (psig) times the internal area of the pipe or piping component (sq. in.); as well as any additional forces due to temperature expansion or contraction or to the weight of pipe and contents.

b. Threaded joints. The use of threaded joints on ductile-iron pipe, plastic pipe or tubing, copper tubing or aluminum tubing is not recommended.

c. Equipment connections. In general the final connection to gas equipment should be made with rigid metallic pipe and fittings except flexible connectors can be used if not expected to be vulnerable to physical abuse. Flexible connectors must be used for residential kitchen ranges and shall be at least 40 in. (1.01 m) long. Flexible connectors can be used for residential dryers as they are not considered vulnerable. Other acceptable uses of flexible connectors include equipment located where accessibility will be limited to qualified personnel. Acceptable examples include equipment in locked equipment rooms, equipment suspended at least 10 feet above floor, and equipment in remote buildings. Flexible connectors must conform with ANSI Z21.45 except flexible connectors for movable food service equipment must conform to ANSI 521.69. In addition to cautions listed in instructions required by the ANSI standards, flexible connectors will not be allowed to pass through equipment cabinets. Accessible gas shutoff valve and coupling are required for each piece of gas equipment.

8. Sizing and capacities of gas piping.

a. General requirements. To determine the size of piping to be used in designing a gas piping system, the following factors must be considered:

(1) Allowable loss in pressure from meter, or service regulator when a meter is not provided, to appliance.
(2) Maximum gas demand to be provided.
(3) Length of piping and number of fittings.
(4) Specific gravity of the gas.
(5) Diversity factor.

b. Description of tables.

(1) The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from manufacturer's Btu input rating of the appliance(s) which will be installed. In case the ratings of the appliances to be installed are not known, table 2 shows the approximate consumption of average appliances of certain types in Btu per hour. To obtain the cubic feet per hour of gas required, divide the total Btu per hour input of all appliances by the average Btu heating value per cubic foot of the gas. The average Btu per cubic foot of the gas in the area of the installation may be obtained from the serving gas supplier.

(2) Capacities for 0.60 specific gravity lowpressure gas (0.5 psig or less) in cubic feet per hour are shown in tables 3 and 4 for different sizes and lengths of iron pipe, or equivalent rigid pipe, and in tables 5 and 6 semirigid tubing. Tables 3 and 5 are based upon a pressure drop of 0.3 inch water column, whereas tables 4 and 6 are based upon a pressure drop of 0.5 inch water column. Pressure drop allowances are included as stated in table titles. The serving gas supplier may assist the designer in designating which table(s) will be used.

(3) Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from tables 3 through 6 unless the authority having jurisdiction specifies that a gravity factor should be applied. When the specific gravity of the gas is greater than 0.70, the gravity factor must be applied. Application of the gravity factor converts the figures given in tables 3 through 6 to capacities with another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in tables 3 through 6 by the multipliers shown in table 7. In case the exact specific gravity does not pear in the table, choose the next higher specific gravity shown in the table.

(4) Capacities in thousands of Btu per hour of undiluted LPG gases based on a pressure drop of 0.5 inch water column for different sizes and lengths are shown in tableS for semirigid tubing, and in table 9 for iron pipe or uivalent rigid pipe. Pressure drop allowances are included as stated in the table titles.

(5) For any gas piping system, for special gas appliances, or for conditions other than those covered by tables 3.

Table 2. Approximate gas input for some common appliances

APPLIANCE	INPUT BTU PER HR (APPROX)
RANGE, FREE STANDING, DOMESTIC	65,000
BUILT-IN OVEN OR BROILER UNIT, DOMESTIC	25,000
BUILT-IN TOP UNIT, DOMESTIC	40,000
WATER HEATER, AUTOMATIC STORAGE 30 TO 40 GAL. TANK	45,000
WATER HEATER, AUTOMATIC STORAGE 50 GAL. TANK	55,000
WATER HEATER, AUTOMATIC INSTANTANEOUS (2 GAL. PER MINUTE)	142,800
CAPACITY (4 GAL. PER MINUTE)	285,000
(6 GAL. PER MINUTE)	428,400
WATER HEATER, DOMESTIC, CIRCULATING OR SIDE-ARM	35,000
REFRIGERATOR	3,000
CLOTHES DRYER, TYPE 1 (DOMESTIC)	35,000
GAS LIGHT	2,500
INCINERATOR, DOMESTIC	35,000

* FOR SPECIFIC APPLIANCES OR APPLIANCES NOT SHOWN ABOVE, THE INPUT SHOULD BE DETERMINED FROM THE MANUFACTURER'S RATING. THE "DIRECTORY OF CERTIFIED APPLIANCES AND ACCESSORIES" PUBLISHED BY THE AMERICAN GAS ASSOCIATION LABORATORIES LISTS THOUSANDS OF GAS APPLIANCES AND ACCESSORIES WHICH COMPLY WITH APPLICABLE NATIONAL STANDARDS.
COURTESY NATIONAL FUEL GAS CODE

Table 3. 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
1/4	0.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
3/8	0.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
1/2	0.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
3/4	0.824	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 4. 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 0.5 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
1/4	0.364	43	29	24	20	18	16	15	14	13	12	11	10	9	8
3/8	0.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
1/2	0.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
3/4	0.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1-1/4	1.380	1,400	950	770	660	580	530	490	460	430	400	360	325	300	280
1-1/2	1.610	2,100	1,460	1,180	990	900	810	750	690	650	620	550	500	460	430
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400	1,300	1,220	1,150	1,020	950	850	800
2-1/2	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100	7,500	7,200	6,700	6,000	5,500	5,000	4,600

Table 5. Maximum capacity of semirigid tubing 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)

OUTSIDE DIAMETER, INCH	LENGTH OF TUBING, FEET													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	20	14	11	10	9	8	7	7	6	6	5	5	4	4
1/2	42	29	23	20	18	16	15	14	13	12	11	10	9	8
5/8	86	59	47	40	36	33	30	28	26	25	22	20	18	17
3/4	150	103	83	71	63	57	52	49	46	43	38	35	32	30
7/8	212	146	117	100	89	81	74	69	65	61	54	49	45	42

Table 6. Maximum capacity of semirigid tubing in cubic feet of gas per hour for gas pressures of 0.5 psig or less and a pressure drop of 0.5 inch water column

(BASED ON A 0.60 SPECIFIC GRAVITY GAS)

OUTSIDE DIAMETER, INCH	LENGTH OF TUBING, FEET													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	27	18	15	13	11	10	9	9	8	8	7	6	6	5
1/2	56	38	31	26	23	21	19	18	17	16	14	13	12	11
5/8	113	78	62	53	47	43	39	37	34	33	29	26	24	22
3/4	197	136	109	93	83	75	69	64	60	57	50	46	42	39
7/8	280	193	155	132	117	106	98	91	85	81	71	65	60	55

Table 7. Multipliers to be used only with tables 3 through 6 when applying the gravity factor

SPECIFIC GRAVITY	MULTIPLIER	SPECIFIC GRAVITY	MULTIPLIER
0.35	1.31	1.00	0.78
0.40	1.23	1.10	0.74
0.45	1.16	1.20	0.71
0.50	1.10	1.30	0.68
0.55	1.04	1.40	0.66
0.60	1.00	1.50	0.63
0.65	0.96	1.60	0.61
0.70	0.93	1.70	0.59
0.75	0.90	1.80	0.58
0.80	0.87	1.90	0.56
0.85	0.84	2.00	0.55
0.90	0.82	2.10	0.54

Table 8. Maximum capacity of semirigid tubing in thousands of Btu per hour of undiluted liquefied petroleum gases for gas pressure drop of 0.5 inch water column (at 11 inches water column inlet pressure)

OUTSIDE DIAMETER, INCH	LENGTH OF TUBING, FEET									
	10	20	30	40	50	60	70	80	90	100
3/8	39	26	21	19	--	--	--	--	--	--
1/2	92	62	50	41	37	35	31	29	27	26
5/8	199	131	107	90	79	72	67	62	59	55
3/4	329	216	181	145	131	121	112	104	95	90
7/8	501	346	277	233	198	187	164	155	146	138

Table 9. Maximum capacity of pipe in thousands of Btu per hour of undiluted petroleum gases for pressure drop of 0.5 inch water column (at 11 inches water column inlet pressure)

NOMINAL IRON PIPE SIZE INCHES	LENGTH OF PIPE, FEET											
	10	20	30	40	50	60	70	80	90	100	125	150
1/2	275	189	152	129	114	103	96	89	83	78	69	63
3/4	567	393	315	267	237	217	196	185	173	162	146	132
1	1071	732	590	504	448	409	378	346	322	307	275	252
1-1/4	2205	1496	1212	1039	913	834	771	724	677	630	567	511
1-1/2	3307	2299	1858	1559	1417	1275	1181	1086	1023	976	866	787
2	6221	4331	3465	2992	2646	2394	2205	2047	1921	1811	1606	1496

through 6, 8, or 9, such as longer runs, greater gas demands, or greater pressure drops, the size of each gas piping system should be determined by standard engineering methods acceptable to the authority having jurisdiction and to the serving gas supplier.

(6) If diversity factor or load can be established smaller size piping may be used. The diversity factor indicates the predicted gas demand as a percentage of the total equipment hourly load operating at full capacity simultaneously. This factor depends upon the characteristics of the project and the number and kind of gas appliances being installed. The gas company can suggest the proper factor based on previous experience. On projects of 100 or more families, the maximum hourly flow of gas through the regulator may be as little as 15 percent of the maximum possible demand.

(7) To determine the size of each section of gas pipe in a system within the range of the capacity tables, proceed as described in (a) through (h) below.

(a) Determine the gas demand of each appliance to be connected to the piping system. When tables 3 through 6 are used to select the piping size, calculate the gas demand in terms of cubic feet per hour for each piping system outlet. When tables 8 or 9 are used to select the piping size, calculate the gas demand in terms of thousands of Btu per hour for each piping system outlet.

(b) When the piping system will be used for other than undiluted LPG, determine the design system pressure, the allowable loss in pressure (pressure drop), and the specific gravity of the gas to be used.

(c) Measure the length of piping from the gas meter, or service regulator when a meter is not provided, to the most remote outlet in the system.

(d) In the appropriate capacity table, select the column showing the measured length, or the next longer length if the table does not give the exact length. This is the only length used in determining the size of any section of gas piping. If the gravity factor is to be applied, the values in the selected column of the table are multiplied by the appropriate multiplier from table 7.

(e) Use this vertical column to locate all gas demand figures for this particular system of piping.

(f) Starting at the most remote outlet, find in the vertical column the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.

(g) Opposite this demand figure, in the first column at the left, will be found the correct size of gas piping.

(h) Proceed in a similar manner for each outlet and each section of gas piping. For each section of piping determine the total gas demand to be supplied by that section.

c. *Example of piping system design.*

(1) *Problem.* Determine the required pipe size of each section and outlet of the piping system shown in figure 1, with a designated pressure drop of 0.50 inch water column. Gas to be used has 0.65 specific gravity and a heating value of 1,000 Btu per cubic foot.

(2) *Solution.*

(a) *Maximum gas demand for outlet A:*

$$\frac{\text{Consumption (rating plate input, or table 2 if necessary}}{\text{Btu of Gas}} =$$

$$\frac{\text{30,000 Btu per hour rating}}{\text{1,000 btu per cubic foot}} = 30 \text{ Cubic feet per hour (30 cfh)}$$

(b) *Maximum gas demand for outlet B:*

$$\frac{\text{Consumption}}{\text{Btu of gas}} \quad \frac{3{,}000}{1{,}000} = 3 \text{ cfh}$$

(c) *Maximum gas demand on outlet C:*

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{75{,}000}{1{,}000} = 75 \text{ cfh}$$

(d) *Maximum gas demand for outlet D:*

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{136{,}000}{1{,}000} = 136 \text{ cfh}$$

(e) The length of pipe from the gas meter to the most remote outlet (A) is 60 feet. This is the only distance used.

(f) Using the column marked 60 feet in table 4 (provided this is the table designated for use by the serving gas supplier):

Outlet A, supplying 30 cfh, requires 3/8-inch pipe.

Outlet B, supplying 3 cfh, requires 1/4-inch pipe.

Section 1, supplying outlets A and B, or 33 cfh, requires 3/8-inch pipe. Outlet C, supplying 75 clh, requires 3/4-inch pipe.

Section 2, supplying outlets A, B, and C, or 108 clh, requires 3/4-inch pipe. Outlet D, supplying 136 cfh, requires 3/4-inch pipe.

Section 3, supplying outlets A, B, C and D, or 244 cfh, requires 1-inch pipe.

(g) If the gravity factor (para 8b(3)) is applied to this example, the values in the column marked 60 feet of table 4 would be multiplied by the multiplier (0.96) from table 7, and the resulting cubic feet per hour values would be used to size the piping.

9. Venting appliances.

In the subparagraphs below, the word "listed" signifies the appliance(s) have been tested by the American Gas Association Laboratories, are approved to bear the certification seal of the laboratories and, therefore, are listed in the Directory of Certified Appliances and Accessories published by the American Gas Association Laboratories.

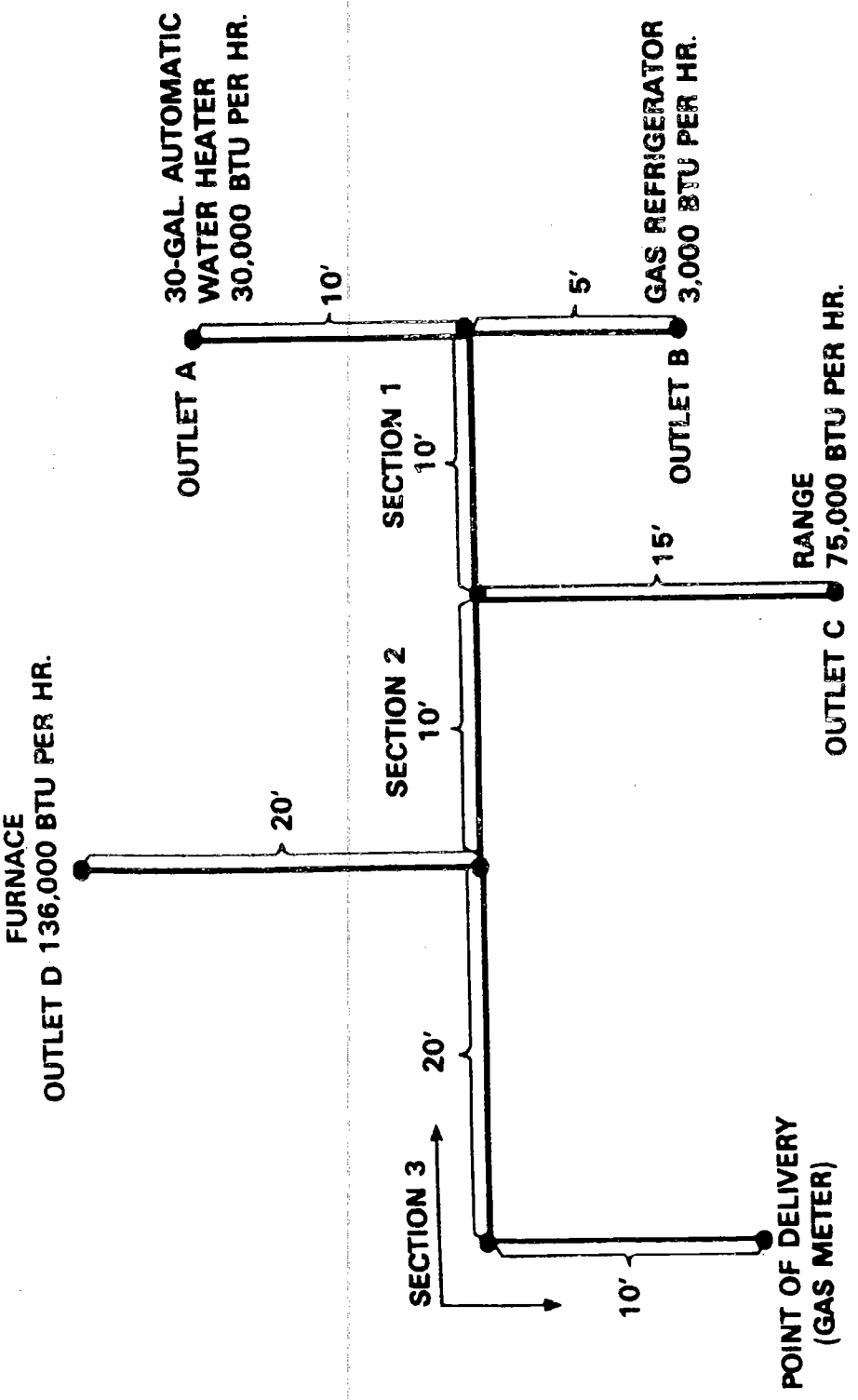

Figure 1. Gas system layout.

a. Appliances requiring venting. Appliances of the following types must be provided with venting systems or other means for removing the flue gases to the outside atmosphere.

(1) Steam and hot water boilers, warm air furnaces, floor furnaces, and wall furnaces.

(2) Unit heaters and duct furnaces.

(3) Incinerators.

(4) Water heaters with inputs over 5,000 Btu per hour, except as provided under (6) and (7) below.

(5) Built-in domestic cooking units listed and marked only as vented units.

(6) Room heaters listed only for vented use. Room heaters listed as "vented and unvented" units may be installed unvented, subject to the approval of the authority having jurisdiction. However, room heaters installed in sleeping quarters for use of transients must be vented by one of the methods described in NFPA 54 and also must be equipped with a safety shutoff device.

(7) Type 2 clothes dryers.

(8) Appliances equipped with gas conversion burners.

(9) Other listed appliances which have draft hoods supplied by the appliance manufacturer.

(10) Unlisted appliances.

b. Appliances not requiring venting.

(1) Listed ranges.

(2) Built-in domestic cooking units listed and marked as unvented units.

(3) Listed hot plates and listed laundry stoves.

(4) Listed Type 1 clothes dryers unless installed in bedrooms or bathrooms.

(5) Listed water heaters with inputs not over 5,000 Btu per hour.

(6) Automatically controlled instantaneous water heaters which supply water to a single faucet which is attached to and made a part of the appliance unless installed in bathrooms, bedrooms, or any occupied rooms normally kept closed. (Single-faucet automatic instantaneous water heaters must not be installed in kitchen sections of light housekeeping rooms or rooms used by transients.)

(7) Listed refrigerators.

(8) Counter appliances.

(9) Room heaters listed for unvented use. However, room heaters installed in all sleeping quarters or in rooms generally kept closed should be vented and equipped with a safety shutoff device.

(10) Other appliances listed for unvented use and not provided with flue collars.

(11) Specialized equipment of limited input such as laboratory burners or gas lights.

Note: When any or all of the appliances in 5 through 11 above are installed so that the aggregate input rating exceeds 30 Btu per hour per cubic foot of room or space in which they are installed, one or more of them will be provided with a venting system or other approved means for removing the vent gases to the outside atmosphere so that the aggregate input rating of the remaining unvented appliances does not exceed the 30 Btu per hour per cubic foot figure. When the room or space in which they are installed is directly connected to another room or space by a doorway, archway, or other opening of comparable size, which cannot be closed, the volume of such adjacent room or space may be included in the calculations. c.Venting requirements. Minimum safety requirements, design requirements, types of venting systems selected, materials for all gas vents including outside vents and chimneys, vent sizes, vent supports, gas vent identification "marking" requirements, and vent connector design and materials will conform to NFPA 54. Special venting arrangements required for the project will be shown in detail on the project drawings.

APPENDIX A
REFERENCES

Government Publications.

Department of the Anny	
TM 5-811-7	Electrical Design, Cathodic Protection
Department of Defense	
MIL-HDBK-1004/10	Military Handbook, Electrical Engineering, Cathodic Protection
Department of Transportation	
Title 49, Part 192.59 of the Code of Federal Regulations, 1979	Transportation of Natural and Other Gas Pipeline: Minimum Federal Safety Standards

Nongovernment Publications.

American Gas Association (AGA), 1515 Wilson Blvd., Arlington, VA 22209

A.G.A. Plastic Pipe Manual for Gas Service, February 1985

American National standards Institute, Inc. (ANSI), Dept. 671,1430 Broadway, New York, NY 10018

B31.2-1968	Fuel Gas Piping
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