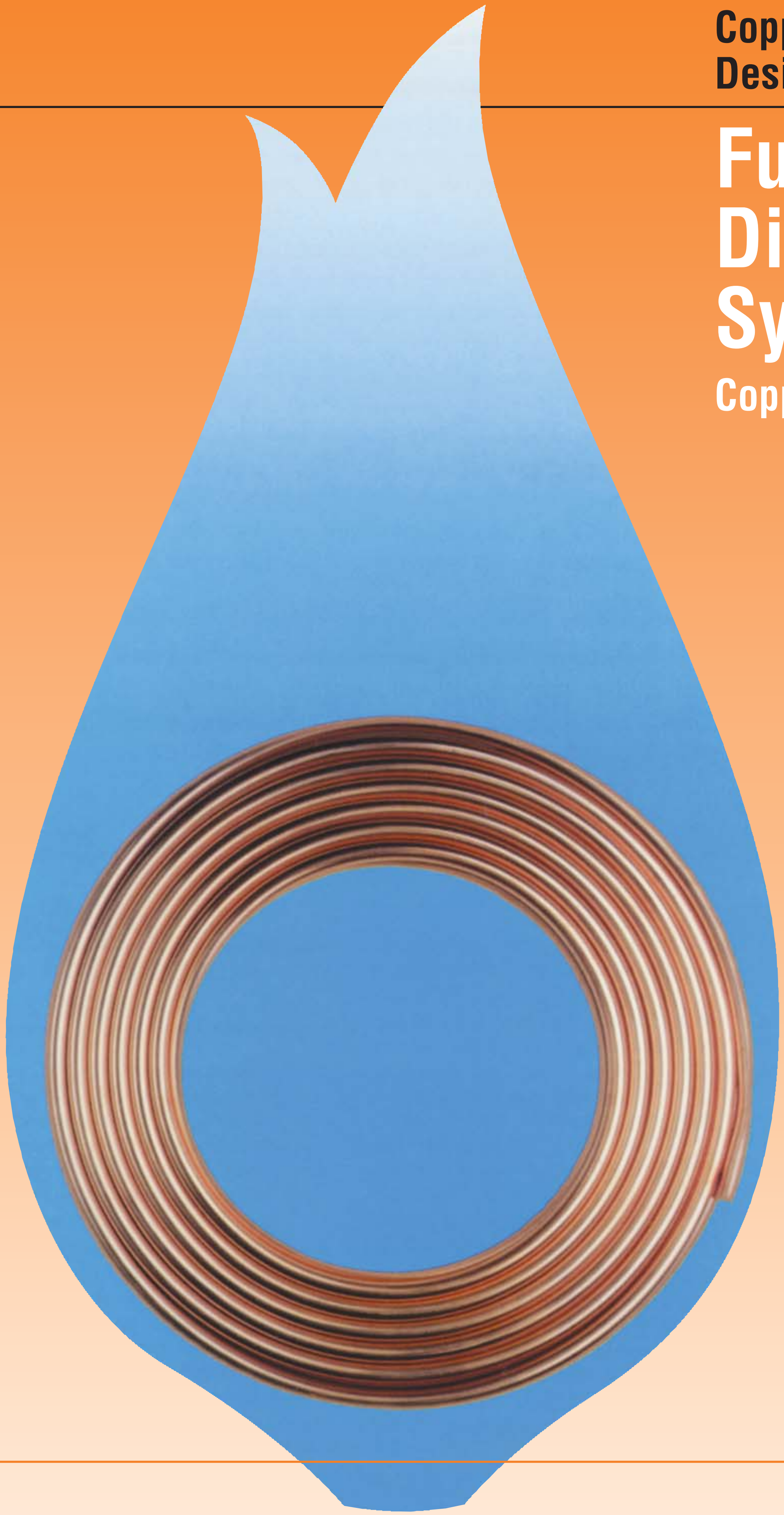
Copper Brass Bronze
Design Guide

Fuel Gas Distribution Systems

Copper Tube



CDA

Copper Development Association

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It is strongly recommended that gas systems be installed by authorized contractors in accordance with local codes. All installations or changes to existing systems must be inspected by the local code authority. Local gas companies will provide guidance on authorized contractors and inspection procedures.

INTRODUCTION

For decades, the excellent performance of copper tube has been well established in a variety of environments. Installations of domestic water, sanitary drainage, medical gas, heating, refrigeration, air conditioning, solar and fire sprinkler systems are some well-known applications. Until recently, nearly all interior fuel gas distribution systems in residential applications have used threaded steel pipe.

Some areas of the United States, however, have extensive experience using copper tube for distribution of natural and liquified petroleum (LP) gas, ranging from single-family attached and detached to multistory, multifamily dwellings. In addition, copper gas distribution lines have been installed for many years in commercial buildings such as strip malls, hotels and motels.

CODES

Based on tests carried out by the Gas Research Institute, and with more than 35 years of successful use of copper by certain gas companies in the United States, major code bodies in the USA and Canada have approved copper tube for fuel gas systems. In 1989 in the USA, provisions for the use of copper tube and copper alloy fittings for interior distribution systems were incorporated in the National Fuel Gas Code (ANSI Z223.1/NFPA 54). Similar provision is made in the Canadian document CAN/CGA-B149.1, Natural Gas Installation Code. Since then, there has been an increasing demand for information on this application. The National Fuel Gas Code also provides for the use of copper tube and copper alloy fittings for underground service lines from the main to the meter.

INFORMATION

This publication is intended for the information and guidance of professionals dealing with the design and installation of copper tube in natural and LP gas distribution systems. Many local regulatory authorities have adopted the National Fuel Gas Code, some with additional requirements for use within their jurisdictions. Designers and installers of systems should check with the authority having jurisdiction (AHJ) and with the company supplying the gas, to find the exact regulations in force.

THE ADVANTAGES OF COPPER TUBE

Modern residential units use many kinds of gas equipment and appliances. Clean, efficient heating may be achieved by a central furnace or individual room heaters. Central systems frequently have provision for air conditioning. Gas-fired water heaters, noted for their quick recovery rates, are available. Other items could include cooking ranges, ovens, clothes dryers, gas fireplaces, gas barbecues and decorative lighting.

Homeowners, housing developers, builders, installation contractors and gas companies all benefit when copper tube is chosen for the fuel gas distribution system. Copper's main advantages are flexibility (particularly in confined spaces), resistance to corrosion, easy joining and its availability in long lengths. Lengths of up to 100 feet are standard, with longer lengths available on request.

These factors lead to an easier, cleaner, less time-consuming installation and lower costs. For single-family dwellings, copper is often the least expensive installation. In multistory residences, the use of copper gas distribution systems can make the installation cost of natural gas service competitive with that of electricity for heating, laundry and cooking applications.

Owners of condominium units and tenants of rental apartments are often responsible for payment for their individual utility services. Copper tube readily makes vertical subdivision more cost effective because it allows the gas utility to group individual meters without the cost and typical problems associated with piping in such compact configurations.

With careful planning and using long lengths of copper tube, all the joints usually contained in walls, floors and ceilings may be eliminated. And, fewer joints mean improved safety. Long lengths, compact dimensions and ease of joining are particularly important advantages of copper for retrofit systems. For present gas consumers, copper tube offers maximum ease of installation when they wish to add gas equipment and appliances.

For example, fuel gas can be supplied to fireplaces located virtually anywhere in a home quickly and economically without the difficulties associated with threaded pipe.

When direct venting or induced draft techniques are used, gas fireplace installation in single-family and multi-story units is simplified further because a conventional chimney is not required.

SPECIFYING COPPER TUBE

Table 1 identifies the different types of copper tube allowable for use in fuel gas distribution systems in the USA and parts of Canada, along with the identification and availability of each type. Types K and L copper tube (ASTM B 88) and ACR tube (ASTM B 280), up to and including 1⅝-inch outside diameter, have been used in fuel gas systems for many years. Usually, Type L is used for interior distribution systems and Type K for any underground lines. Though not used in the USA, seamless copper tube Type GAS (ASTM B 837) is required in certain regions of Canada for gas distribution systems.

The dimensions of copper tube used for gas installations are shown in **Table 2**. Tube and fittings in fuel gas systems are usually identified by their outside diameter (O.D.) rather than their nominal sizes. Designers and installers should be specific with size designations in their references and when ordering.

Copper and copper alloy tube (except tin-lined copper tube) should not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L).

CHOICE OF SYSTEM

The two classifications of fuel gas distribution systems that may be installed using copper tube are known as:

- Low pressure: Less than 14" wc (water column) or ½ psig (pounds per square inch gauge).
- Elevated pressure: 14" wc (½ psig) to 5 psig.

The system designer should consult with the gas company regarding available pressure and metering requirements for each installation.

Currently in the United States, 2 psig tends to be the most commonly used elevated pressure system for residential

TABLE 1. Copper Tube: For Gas Installation.

Tube Type	Color Code	Standard	Application	Commercially Available Lengths[1] Nominal or Standard Sizes	Drawn[2]	Annealed[2]
TYPE K	Green	ASTM B 88	Domestic Water Service and Distribution, Fire Protection, Solar, Fuel/Fuel Oil, Natural Gas, Liquified Petroleum (LP) Gas, HVAC, Snow Melting	**STRAIGHT LENGTHS:**		
				¼-inch to 8-inch	20 ft	20 ft
				10-inch	18 ft	18 ft
				12-inch	12 ft	12 ft
				COILS:		
				¼-inch to 1-inch	—	60 ft
					—	100 ft
				1¼-inch and 1½-inch	—	60 ft
				2-inch	—	40 ft
					—	45 ft
TYPE L	Blue	ASTM B 88	Domestic Water Service and Distribution, Fire Protection, Solar, Fuel/Fuel Oil, Natural Gas, Liquified Petroleum (LP) Gas, HVAC, Snow Melting	**STRAIGHT LENGTHS:**		
				¼-inch to 10-inch	20 ft.	20 ft.
				12-inch	18 ft.	18 ft.
				COILS:		
				¼-inch to 1-inch	—	60 ft.
					—	100 ft.
				1¼-inch to 1½-inch	—	60 ft.
				2-inch	—	40 ft.
					—	45 ft.
ACR	Blue	ASTM B 280	Air Conditioning, Refrigeration, Natural Gas, Liquified Petroleum (LP) Gas	**STRAIGHT LENGTHS:**		
				⅜-inch to 4⅛-inch	20 ft.	[3]
				COILS:		
				⅛-inch to 1⅝-inch	—	50 ft.

[1] Individual manufacturers may have commercially available lengths in addition to those shown on this table.

[2] Drawn (hard) temper tube has higher strength than annealed tube and is supplied in straight lengths only. Annealed (soft) temper tube has a lower strength than drawn tube but is easily bent or formed. Annealed tube is available in straight lengths and continuous coils.

[3] Available as special order only.

and light commercial installations. However, 2 psig is not the only pressure at which gas can be delivered, and the system pressure selected must be compatible with available delivery pressures and other system requirements. For some installations, the elevated pressure system may be impractical or unnecessary; whereas, a low pressure system may be quite adequate and acceptable. The lowest pressure system that will provide proper operation is preferred, but when sizing indicates tube sizes of ⅞" O.D. or greater, consideration should be given to using an elevated pressure system and smaller tube sizes.

Low pressure systems are used when the gas company serving the consumer either operates a low pressure (less than 14" wc) distribution system or sets its service regulator to reduce the gas pressure at the meter to this lower pressure. In an elevated pressure system, the gas pressure is reduced at the meter by the service regulator to ½ to 5 psig. This pressure is further reduced to less than 14" wc by a line regulator located within the house piping system at the appliance or a distribution manifold.

In either of the above systems, the tube must be of sufficient size to provide a supply of gas to meet the requirements of volume and pressure at the point of use. The differences in the capacities of the low pressure and elevated pressure systems, measured in cubic feet per hour (CFH), may be noted

TABLE 2. Dimensions and Physical Characteristics of Copper Tube: TYPES K, L, ACR.

Outside Diameter (inches)	Tube Type[1]	Nominal or Standard Size, (inches)	Inside Diameter (inches)	Wall Thickness (inches)	Cross Sectional Area of Bore, (sq inches)	Weight of Tube Only, (pounds per linear ft)	Contents of Tube per Linear Foot (cubic feet)
0.375	K	¼	0.305	0.035	0.073	0.145	0.00051
	L	¼	0.315	0.030	0.078	0.126	0.00054
	ACR (D)	⅜	0.315	0.030	0.078	0.126	0.00054
	ACR (A)	⅜	0.311	0.032	0.076	0.134	0.00053
0.500	K	⅜	0.402	0.049	0.127	0.269	0.00088
	L	⅜	0.430	0.035	0.145	0.198	0.00101
	ACR (D)	½	0.430	0.035	0.145	0.198	0.00101
	ACR (A)	½	0.436	0.032	0.149	0.182	0.00103
0.625	K	½	0.527	0.049	0.218	0.344	0.00151
	L	½	0.545	0.040	0.233	0.285	0.00162
	ACR (D)	⅝	0.545	0.040	0.233	0.285	0.00162
	ACR (A)	⅝	0.555	0.035	0.242	0.251	0.00168
0.750	K	⅝	0.652	0.049	0.334	0.418	0.00232
	L	⅝	0.666	0.042	0.348	0.362	0.00242
	ACR (D, A)	¾	0.666	0.042	0.348	0.362	0.00242
	ACR (A)	¾	0.680	0.035	0.363	0.305	0.00252
0.875	K	¾	0.745	0.065	0.436	0.641	0.00303
	L	¾	0.785	0.045	0.484	0.455	0.00336
	GAS	⅞	0.785	0.045	0.484	0.455	0.00336
	ACR (D, A)	⅞	0.785	0.045	0.484	0.455	0.00336
1.125	K	1	0.995	0.065	0.778	0.839	0.00540
	L	1	1.025	0.050	0.825	0.655	0.00573
	ACR (D, A)	1⅛	1.025	0.050	0.825	0.655	0.00573
1.375	K	1¼	1.245	0.065	1.22	1.04	0.00847
	L	1¼	1.265	0.055	1.26	0.884	0.00875
	ACR (D,A)	1⅜	1.265	0.055	1.26	0.884	0.00875
1.625	K	1½	1.481	0.072	1.72	1.36	0.0119
	L	1½	1.505	0.060	1.78	1.14	0.0124
	ACR (D,A)	1⅝	1.505	0.060	1.78	1.14	0.0124
2.125	K	2	1.959	0.083	3.01	2.06	0.0209
	L	2	1.985	0.070	3.09	1.75	0.0215
	ACR (D)	2⅛	1.985	0.070	3.09	1.75	0.0215
2.625	K	2¼	2.435	0.095	4.66	2.93	0.0324
	L	2½	2.465	0.080	4.77	2.48	0.0331
	ACR (D)	2⅝	2.465	0.080	4.77	2.48	0.0331
3.125	K	3	2.907	0.109	6.64	4.00	0.0461
	L	3	2.945	0.090	6.81	3.33	0.0473
	ACR (D)	3⅛	2.945	0.090	6.81	3.33	0.0473

[1] D = Drawn temper, A = Annealed Temper.

by comparing the values in **Tables 3, 4, 5** and **6**. **Table 3** is for low pressure systems, or that portion of an elevated pressure system operating at less than 14" wc, and is based on a pressure drop of 0.5" wc. **Table 4** is also for low pressure systems or that portion of an elevated pressure system operating at less than 14" wc and is based on a pressure drop of 1.0" wc. **Tables 5** and **6** are for elevated pressure systems and are based on delivery pressures (at sea level) of 2 psig and 5 psig and pressure drops of 1.0 psig and 3.5 psig, respectively.

Tables 3 through **6** include a 20% factor to allow for a reasonable number of fittings and are based on gas with a specific gravity of 0.60. See **Table 7** for gas with a specific gravity other than 0.60. The capacities in these tables were conservatively determined based on the dimensions of Type K tube and are suitable for use with ASTM B 88 Types K and L tube, ASTM B 280 Type ACR tube and Type Gas tube made to ASTM B 837.

The capacities listed in **Tables 3** through **6** are for a tube of the stated size and parameters only and do not consider the limitations or effects of regulators or other system components. Many of the values listed indicate large capacities that can be delivered using the stated tube size. Realistically however, other system components, such as regulators, may not be able to handle or deliver these quantities of gas. The system designer should recognize that the limitations of these components may govern the capacity of the system.

The pressure drop values used in **Tables 3** through **6** are commonly used pressure drops for each type of system. However, the limit for pressure drop between the outlet of the meter and the regulator at a manifold or an appliance can be quite high, as long as the inlet pressure to the regulator is sufficient to allow the required flow and delivery pressure downstream of the regulator. Local codes should be consulted for limits on allowable pressure drop in the system to determine the applicability of **Tables 3** through **6.** For pressure drops other than those used in the tables, the capacity of the tube can be calculated using guidance from Annex C of the National Fuel Gas Code.

IDENTIFICATION

Specific identification requirements are dependent on the applicable local codes, however it is recommended that each system be clearly marked with appropriate labels to identify the system as a gas system, the system type (low pressure, elevated pressure) and, for elevated pressure systems, the system delivery pressure. The low pressure system can use the label shown in **Figure 1**, while the elevated pressure system can use markings similar to that shown in **Figure 2**. These labels should be affixed to the tube on both sides of a wall, floor or partition and at maximum six-foot intervals throughout the length of the tube runs.

LAYING OUT COPPER SYSTEMS

Using good engineering practice, a system can be optimally designed using the smallest allowable size of tube that will supply gas to the appliance with appropriate volume and pressure.

For a single-family dwelling, the gas company will frequently install the meter outdoors and terminate its facilities with a 1" NPS (Nominal Pipe Size) threaded connection outside the building. The transition to copper tube can either be made at that point or a ½" (or larger) NPS steel pipe can be extended through the exterior wall and the transition to copper made inside the building (as shown in

TABLE 3. Maximum Capacity* for Copper Tube in a Low Pressure System of Less than 14 inches wc and Pressure Drop of 0.5 inches wc, CFH.**

Length of Tube, feet	Outside Diameter of Tube, inches						
	⅜	½	⅝	¾	⅞	1⅛	1⅜
10	24	50	101	176	250	535	963
20	17	34	69	121	172	368	662
30	13	27	56	97	138	295	531
40	11	23	48	83	118	253	455
50	10	21	42	74	105	224	403
60	9.1	19	38	67	95	203	365
70	8.4	17	35	62	87	187	336
80	7.8	16	33	57	81	174	313
90	7.3	15	31	54	76	163	293
100	6.9	14	29	51	72	154	277
125	6.1	13	26	45	64	136	245
150	5.6	11	23	41	58	124	222
175	5.1	11	21	38	53	114	205
200	4.8	10	20	35	50	106	190
250	4.2	8.7	18	31	44	94	169

****Includes 20% factor for fittings. **See Table 7.***

TABLE 4. Maximum Capacity* for Copper Tube in a Low Pressure System of Less than 14 inches wc and Pressure Drop of 1 inch wc, CFH.**

Length of Tube, feet	Outside Diameter of Tube, inches						
	⅜	½	⅝	¾	⅞	1⅛	1⅜
10	35	72	147	257	364	778	1,401
20	24	50	101	176	250	535	963
30	19	40	81	142	201	429	773
40	17	34	69	121	172	368	662
50	15	30	61	107	152	326	586
60	13	27	56	97	138	295	531
70	12	25	51	90	127	272	489
80	11	23	48	83	118	253	455
90	11	22	45	78	111	237	427
100	10	21	42	74	105	224	403
125	8.9	18	37	65	93	198	357
150	8.1	17	34	59	84	180	324
175	7.4	15	31	55	77	165	298
200	6.9	14	29	51	72	154	277
250	6.1	13	26	45	64	136	245

****Includes 20% factor for fittings. **See Table 7.***

Figure 3). In either case, care should be taken to ensure that the copper tube is not used to support the meter or exterior piping. This can be accomplished by anchoring the meter or the steel pipe passing through the exterior wall. Some gas companies will set the meter with a brace or bracket and run copper tube through to the outside so service personnel are aware that it is a semirigid system and damage can be avoided.

The connection between the steel system and copper system does not create a corrosion concern if the connection is made in a dry location or a location that does not allow moisture to collect at the connection. The absence of continuous moisture prevents the occurence of galvanic action and subsequent corrosion of the steel pipe.

There are two basic types of piping layouts. One uses a main run with branch lines to supply gas to the various appliances. The other employs individual runs to each appliance from a gas distribution manifold installed between the meter and the appliances, as shown in **Figure 4**. Depending on the building being supplied, a combination of these two systems may also be used.

A typical layout for an apartment complex is shown in **Figure 5**. This system uses a space heater (or a combined heating-cooling unit) for each apartment or condominium. The use of copper tube provides simpler, more economical installation of meter banks to provide individual metering. A typical method of providing banks or groups of meters for a multifamily building is shown in **Figure 6**.

A low pressure house layout with branch runs is shown in **Figure 7**, and one with individual runs is shown in **Figure 8**. Typical combination layouts, elevated and low pressure, are shown in **Figures 9** through **12**. **Figures 9** and **10** show single-regulated systems with either branched or individual runs.

Figures 11 and **12** show multiple-regulated systems of the same configuration.

SIZING COPPER SYSTEMS

Sizing a gas distribution system, whether it is a low pressure or elevated pressure system, follows the same basic procedure. The procedure outlined in this section follows the recommendations in Appendix C of the National Fuel Gas Code. This method is the one most commonly used for sizing gas piping. However, it does not attempt to optimize

FIGURE 1.

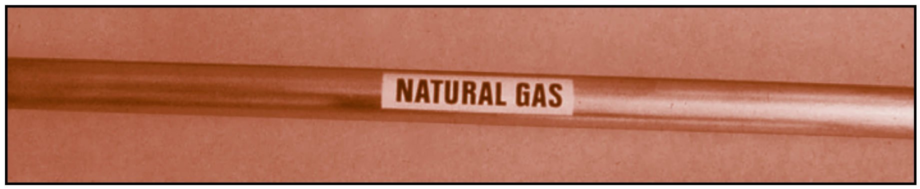


FIGURE 2.

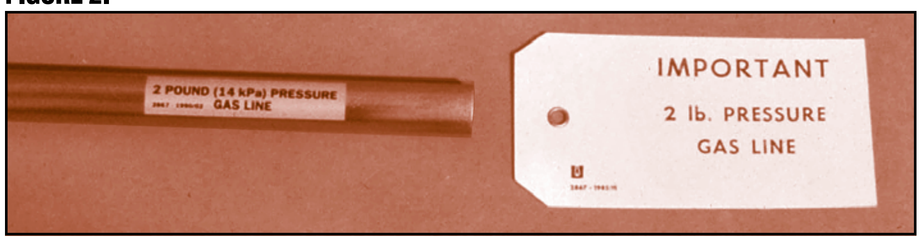


TABLE 5. Maximum Capacity* for Copper Tube in an Elevated Pressure System of 2 psig and Pressure Drop of 1.0 psig., CFH. (Based on atmospheric pressure at sea level.)**

Length of Tube, feet	Outside Diameter of Tube, inches						
	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8
10	222	458	932	1629	2311	4937	8889
20	153	315	641	1120	1589	3393	6109
30	123	253	515	899	1276	2725	4906
40	105	216	440	770	1092	2332	4199
50	93	192	390	682	968	2067	3721
60	84	174	354	618	877	1873	3372
70	78	160	325	569	807	1723	3102
80	72	149	303	529	750	1603	2886
90	68	140	284	496	704	1504	2708
100	64	132	268	469	665	1421	2558
125	57	117	238	415	589	1259	2267
150	51	106	215	376	534	1141	2054
175	47	97	198	346	491	1050	1890
200	44	91	184	322	457	976	1758
250	39	80	163	286	405	865	1558

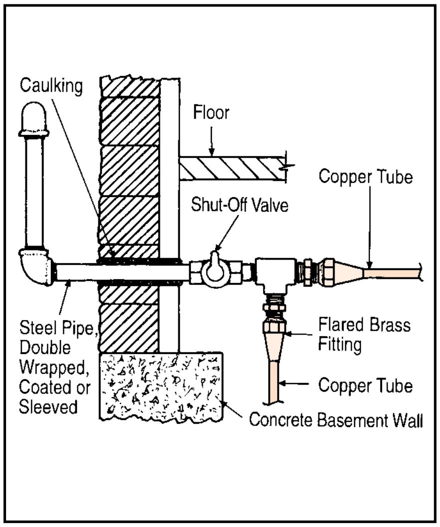
****Includes 20% factor for fittings. **See Table 7.***

TABLE 6. Maximum Capacity* for Copper Tube in an Elevated Pressure System of 5 psig and Pressure Drop of 3.5 psig, CFH. (Based on atmospheric pressure at sea level.)**

Length of Tube, feet	Outside Diameter of Tube, inches						
	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8
10	462	954	1941	3392	4812	10279	18504
20	318	656	1334	2331	3307	7064	12718
30	255	527	1071	1872	2656	5673	10213
40	218	451	917	1602	2273	4855	8741
50	194	399	812	1420	2015	4303	7747
60	175	362	736	1287	1825	3899	7019
70	161	333	677	1184	1679	3587	6458
80	150	310	630	1101	1562	3337	6008
90	141	291	591	1033	1466	3131	5637
100	133	274	558	976	1385	2958	5324
125	118	243	495	865	1227	2621	4719
150	107	220	448	784	1112	2375	4276
175	98	203	413	721	1023	2185	3934
200	91	189	384	671	952	2033	3659
250	81	167	340	594	843	1802	3243

****Includes 20% factor for fittings. **See Table 7.***

FIGURE 3. Typical transition to copper tube when there is steel pipe from the exterior meter.



tube size to minimize material cost. This method is simply a recommendation. More rigorous engineered sizing methods may be used, provided they are acceptable to the authority having jurisdiction.

First, a sketch of the planned system should be prepared showing the distance between connections and the individual gas load at each appliance. Gas demand, or input rating information, can be determined from the appliance rating plate or the appliance manufacturer. In cases where specific appliance load data are not available, consult the National Fuel Gas Code for generic appliance input load ratings. If **Tables 3** through **6** of this document are to be used to size the system, gas demand values should be calculated in terms of cubic feet per hour (CFH).

The design pressure of the system, allowable pressure drop and specific gravity of the gas supply should be determined. Also, the length of the piping should be measured from the point of delivery (the meter in a low pressure system or the elevated to low pressure (line) regulator upstream of the low pressure portion of an elevated pressure system) to the most remote outlet in the building. This "longest" length will be the only length used in determining the size of any section of the gas piping in this portion of the system.

In the appropriate capacity table (**Tables 3** and **4** for low pressure portions of systems and **Tables 5** and **6** for elevated pressure portions), the row

FIGURE 4. Schematic diagram of a distribution manifold system.

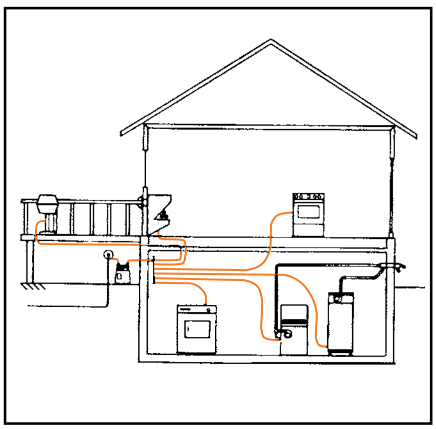


FIGURE 5. Example of vertical subdivision in a multistory residential building.

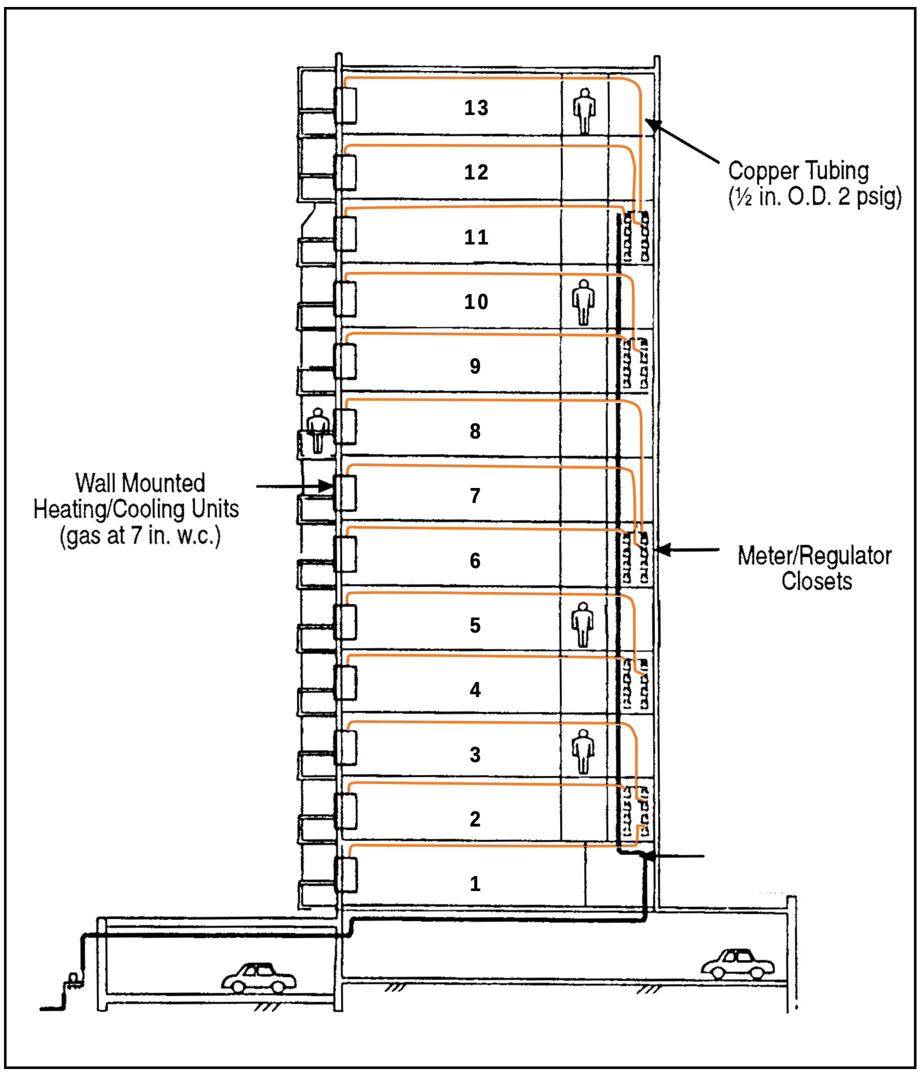


FIGURE 6. Typical meter bank for multifamily building.

FIGURE 7. Low pressure system with branch runs.

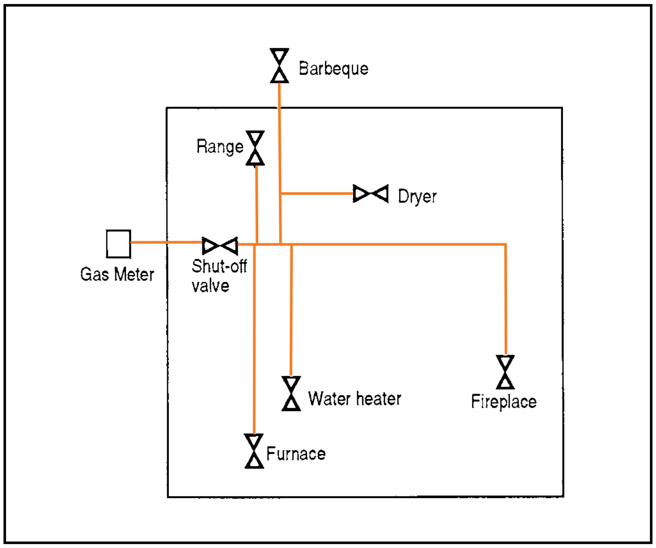


FIGURE 8. Low pressure system with individual runs.

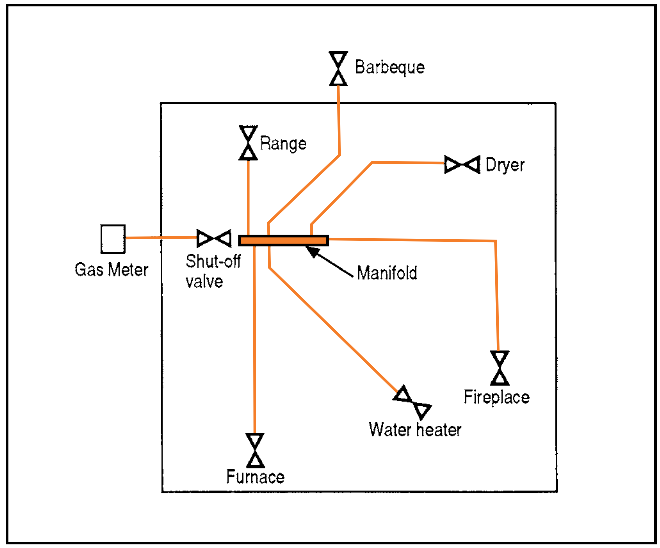


FIGURE 9. Single-regulated elevated pressure system with branch runs.

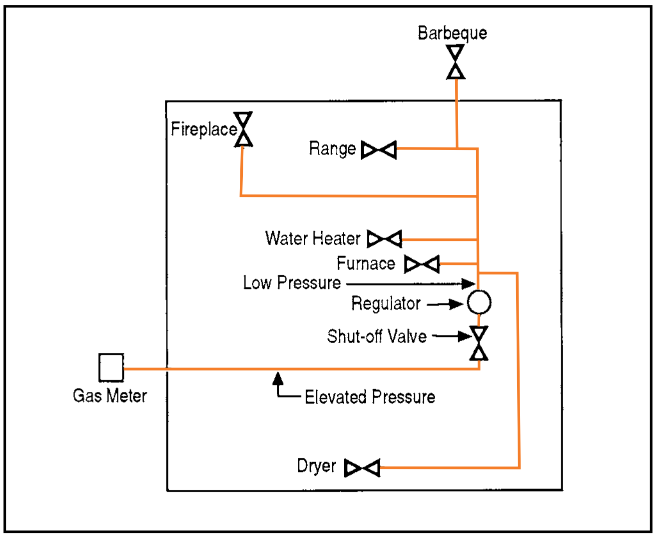


FIGURE 10. Single-regulated elevated pressure system with individual runs.

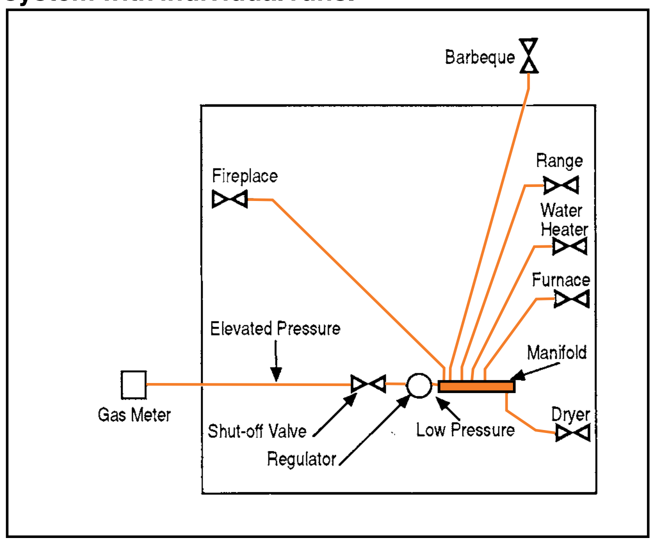


FIGURE 11. Multiple-regulated pressure system with branch runs.

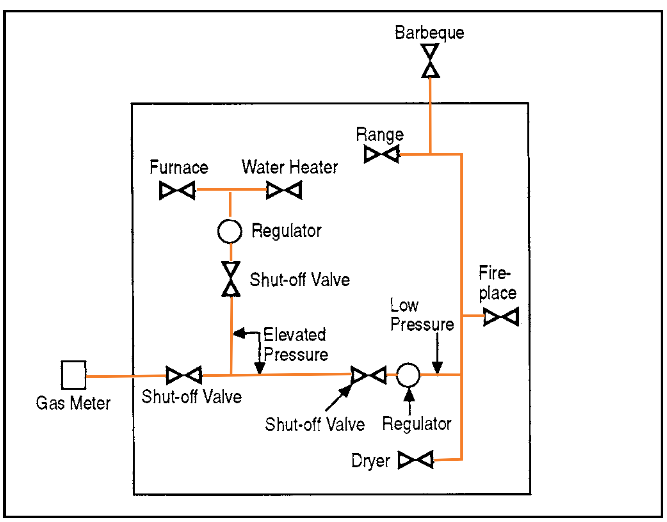
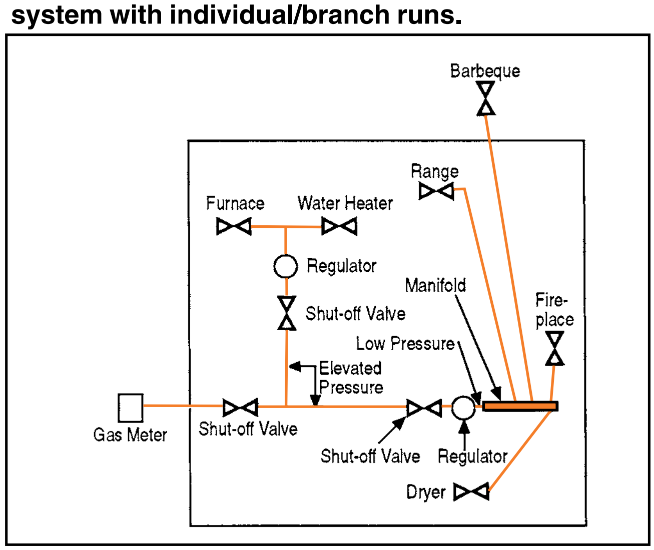


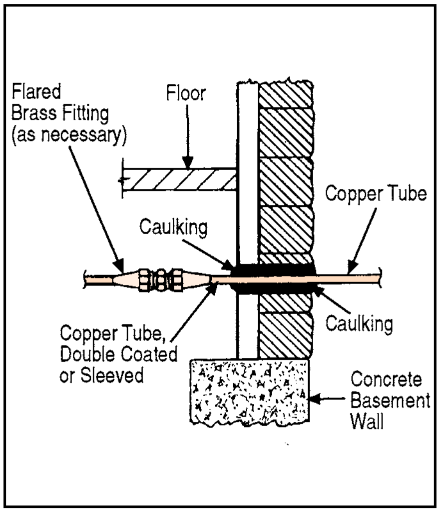
FIGURE 12. Multiple-regulated elevated pressure system with individual/branch runs.



showing this "longest" length (or the row showing the next longer length if the table does not list the exact length) should be selected. If it was determined that the gas supplied has a specific gravity other than 0.60, on which the tables were based, it will be necessary to multiply the values in the selected row by the appropriate factor from **Table 7.** The adjusted values in the selected row should be used to locate *all* gas demand values for the particular portion of the piping system. Then, starting at the most remote outlet or connection, find in the selected horizontal capacity row the gas demand required at that point. If the exact gas demand value is not shown, the next larger value in the same row (to the right) should be chosen. Above this demand value (at the top of the table) is the correct size of tube to be used in supplying this capacity. This method should be used to size each outlet and section of piping. For each section of piping, the total gas demand supplied by that section should be used to determine the tube size.

In the case of the elevated pressure system, this procedure should then be used to size the portion of the piping from the meter to the elevated to low pressure (line) regulator. The "longest" length used to determine the size of the piping in this section should be taken as the distance from the meter to the most remote elevated to low pressure regulator.

FIGURE 14. Copper tube through an exterior wall.



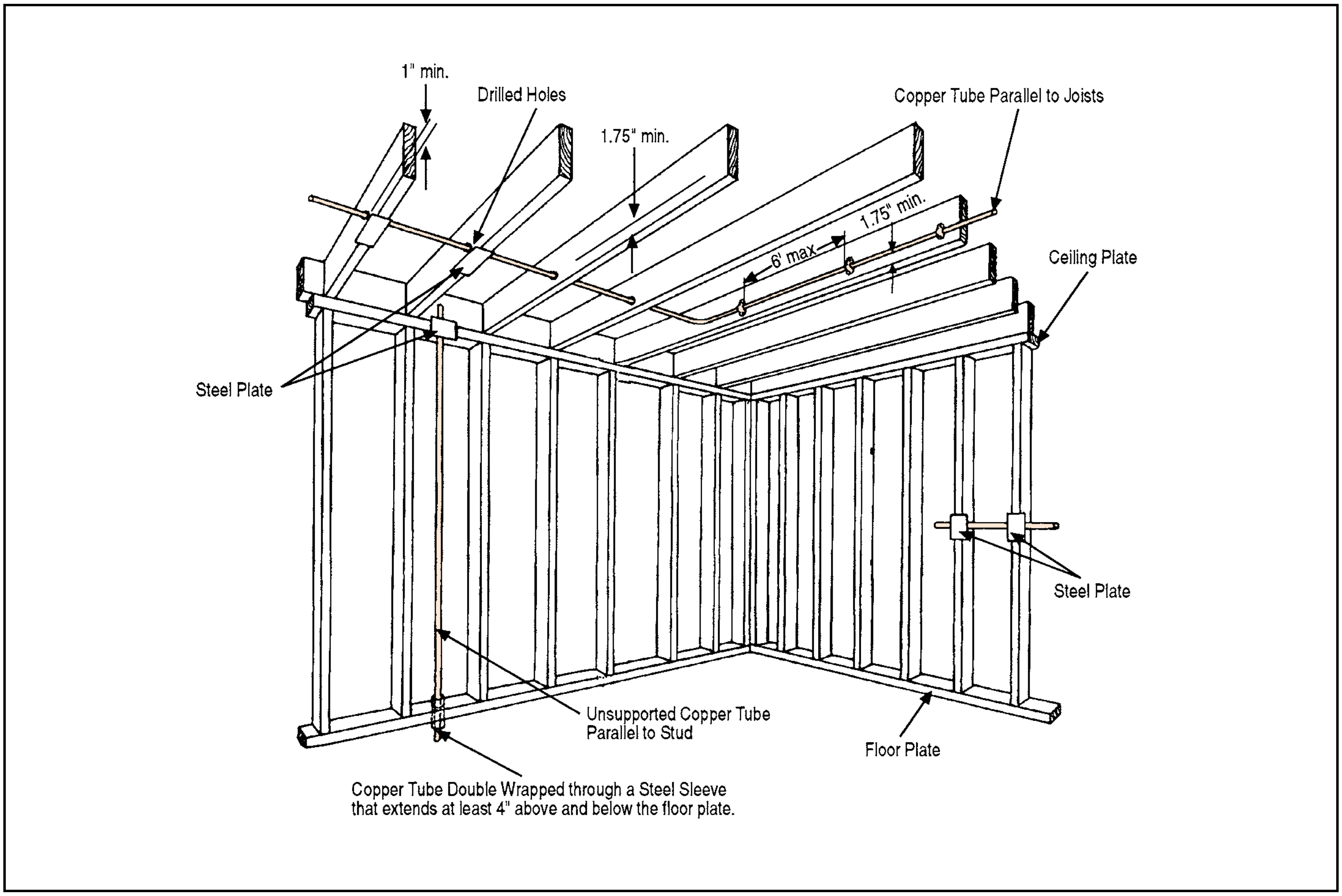
INSTALLING COPPER SYSTEMS

Several procedures should be followed to ensure the protection and safety of copper natural gas lines installed indoors. Some of these are shown in **Figure 13**. In general, it is good practice to install the lines close to beams and close to other services, such as water distribution, conduit and ductwork.

A copper gas line should never be used as a ground for an electrical system.

In areas where excessive moisture is anticipated, dissimilar metal contact should be avoided or prevented by wrapping with an approved tape to

FIGURE 13. Copper tube installation and protection.



avoid the effect of galvanic corrosion on steel hangers or studs.

Copper tube running parallel to the floor joists should be fastened to the center of the vertical face of the joist with clips not more than 6 feet apart. Tube at right angles, or diagonal to the joists, may be installed through holes drilled through the center of the joists. These holes should be at least 1½ times the O.D. of the tube. If the holes are closer than 1.75" to the exposed edge of the joist, the tube should be protected with a steel striker plate 0.0508" thick, minimum. The main function of striker plates is to protect against such items as nails and other fasteners.

The tube may be also fastened to the underside of the joists, using clips every second joist. In such cases, special care must be taken to prevent damage to the tubing.

In partition walls, copper tube passing vertically, *i.e.*, parallel to the studs, does not need to be supported, but it should be protected from puncture with a steel sleeve or steel striker plate where it passes through an upper or lower wall plate. In walls of larger than 2" x 4" construction, protection is only required if the tube is less than 1.75" from an exposed edge.

Steel sleeves may be either steel pipe or made from galvanized sheet steel at least 0.0508" thick and should extend at least 4" above and below the wall plates as shown in **Figure 13**. The tube should be wrapped with an approved tape where it passes through the sleeve to avoid abrasion.

Copper tube for natural gas distribution lines in solid flooring, such as concrete, should be laid in a channel with a cover or encased in ventilated ducts with a free air space around the tube of at least 0.5". Vertical pipe chases also should have openings at the top and the bottom for ventilation.

When copper tube passes through an exterior wall of concrete or masonry, it should be protected by wrapping with an approved tape, installing through a plastic or steel sleeve, and then caulking on each side of the wall for a watertight seal, **Figure 14**. The same requirements apply to similar, interior concrete or masonry walls; caulking is required per applicable building codes.

TABLE 7. Multipliers to be Used with Tables 3 through 6 When Specific Gravity of Gas is Other than 0.60.

Specific Gravity	Multiplier	Specific Gravity	Multiplier
.35	1.31	1.00	.78
.40	1.23	1.10	.74
.45	1.16	1.20	.71
.50	1.10	1.30	.68
.55	1.04	1.40	.66
.60	1.00	1.50	.63
.65	.96	1.60	.61
.70	.93	1.70	.59
.75	.90	1.80	.58
.80	.87	1.90	.56
.85	.84	2.00	.55
.90	.82	2.10	.54

Adjustment for a gas with an average specific gravity (relative density) other than 0.60 is achieved by multiplying the CFH values in **Tables 3** through **6** by the appropriate multiplier.

According to the National Fuel Gas Code, underground piping must be installed with at least 18 inches of cover. This may be reduced to 12 inches if external damage to the pipe is not likely to result. If this minimum of cover cannot be maintained, piping must be installed in a conduit or it must be bridged. In addition, excessive stressing of the pipe must be prevented where there is heavy vehicular traffic or where soil conditions are unstable and settling of piping or foundation walls could occur. Piping passing through flower beds and other cultivated areas should also be protected. Also, to avoid corrosion, copper tube should never be laid in contact with cinders or soils containing cinders.

COPPER TUBE FITTINGS

For copper natural gas systems joined with flared tube connections, flared brass fittings of a single 45° flare type are used,

FIGURE 15. Flared brass fittings for copper natural gas systems.

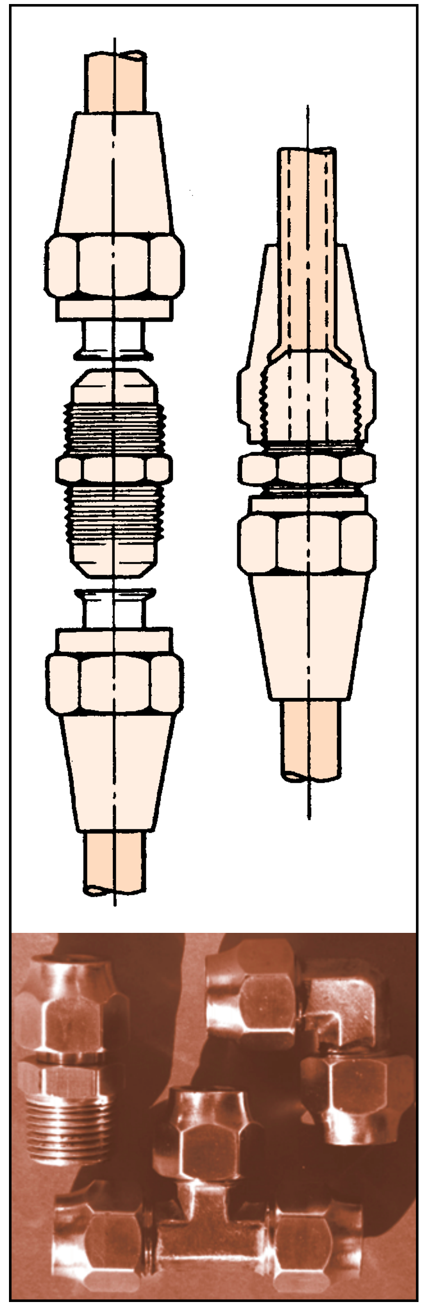


Figure 15. Connections to steel pipe are made with an NPS threaded-to-flared copper adapter. Compression fittings in a gas piping system are not permitted unless allowed by the authority having jurisdiction.

All tube fittings for natural gas installations are rated at more than 125 psig, but should not be used at pressures beyond those allowed by local codes. When branches (tees) are installed, these should be positioned with the branch on the side or the top of the line, unless the branch is a drop to an appliance and is provided with a dirt pocket (drip leg).

In addition to mechanical joints, or in many cases instead of mechanical joints, brazed joints utilizing ASME/ANSI B16.22 wrought copper fittings may be used in copper gas distribution systems. When brazed connections are required, they should be made using a brazing alloy with a melting point above 1,000 F. **The brazing alloy must contain less than 0.05% phosphorus**.

Gas installation regulations aim to avoid joints within walls or other inaccessible places where undetected leakage might cause an accumulation of gas. However, joints in these locations may sometimes be unavoidable. Since mechanical joints are prohibited in inaccessible locations, brazed joints should be used, provided they are approved by the authority having jurisdiction. These joints should be inspected and tested prior to enclosure to ensure a leak-free system. Minimization of joints, especially in inaccessible areas, can be easily accomplished using long, flexible lengths of copper tube.

Approved appliance stops (manual shut-off valves) are required for each appliance and must be readily accessible. Where it is acceptable to the authority having jurisdiction, systems using a distribution manifold may have all the stops at the manifold. In some jurisdictions, dirt pockets are required at the inlet to an appliance regulator or at the base of a vertical drop to an appliance. This dirt pocket may be made up of steel fittings with an NPS to-copper adapter with the flare nut acting as a union, **Figure 16**.

INSPECTION AND TESTING OF SYSTEMS

Although the use of continuous runs of copper tube minimizes the possibility of leaks, systems should be tested according to the code of the authority having jurisdiction. This usually includes pressure testing with air or an inert gas (carbon dioxide or nitrogen) at the pressures and for the durations required.

After all appliances are connected and the gas is turned on, a meter dial test should be conducted for the time period required, and every connection, joint and valve should be checked with an approved leak detector solution.

At this time, the installer should also inspect the system to ensure that striker plates are installed where required and the tube has not been physically damaged or kinked. Damaged or kinked tube should be repaired or replaced in accordance with the requirements of the authority having jurisdiction.

The system is now complete, and a final inspection by the authority having jurisdiction is required during the test period. If the system passes inspection, an approval tag will be issued stating the system is in compliance.

FIGURE 16. Typical dirt pocket installation.