

Table 15.1(a) Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 40

Pipe Length (ft)	½ in. 0.622	¾ in. 0.824	1 in. 1.049	1¼ in. 1.38	1½ in. 1.61	2 in. 2.067	3 in. 3.068	3½ in. 3.548	4 in. 4.026
30	1843	3854	7259	14904	22331	43008	121180	177425	247168
40	1577	3298	6213	12756	19113	36809	103714	151853	211544
50	1398	2923	5507	11306	16939	32623	91920	134585	187487
60	1267	2649	4989	10244	15348	29559	83286	121943	169877
70	1165	2437	4590	9424	14120	27194	76622	112186	156285
80	1084	2267	4270	8767	13136	25299	71282	104368	145393
90	1017	2127	4007	8226	12325	23737	66882	97925	136417
100	961	2009	3785	7770	11642	22422	63176	92499	128859
150	772	1613	3039	6240	9349	18005	50733	74280	103478
200	660	1381	2601	5340	8002	15410	43421	63574	88564
250	585	1224	2305	4733	7092	13658	38483	56345	78493
300	530	1109	2089	4289	6426	12375	34868	51052	71120
350	488	1020	1922	3945	5911	11385	32078	46967	65430
400	454	949	1788	3670	5499	10591	29843	43694	60870
450	426	890	1677	3444	5160	9938	28000	40997	57112
500	402	841	1584	3253	4874	9387	26449	38725	53948
600	364	762	1436	2948	4416	8505	23965	35088	48880
700	335	701	1321	2712	4063	7825	22047	32280	44969
800	312	652	1229	2523	3780	7279	20511	30031	41835
900	293	612	1153	2367	3546	6830	19245	28177	39253
1000	276	578	1089	2236	3350	6452	18178	26616	37078
1500	222	464	875	1795	2690	5181	14598	21373	29775
2000	190	397	748	1537	2302	4434	12494	18293	25483

Note: Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

cal plant. The term *chemical plant* includes all facilities owned by chemical companies where LP-Gas is used primarily as a chemical reactant, process solvent gas, or solvent. However, there is no standard definition of a chemical plant, and facilities in which few or no chemical reactions are carried out may be called chemical plants. [ROP-164]

A.1.3.2(5) For information on the use of LP-Gas with oxygen, see NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, and AWS Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

A.1.3.2(6) Several types of LP-Gas systems are not covered by NFPA 54, *National Fuel Gas Code*, as noted. These include, but are not restricted to, most portable applications; many farm installations; vaporization, mixing, and gas manufacturing; temporary systems, for example, in construction; and systems on vehicles.

A.1.3.2(8) For information on the use of LP-Gas in vessels, see NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an

organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction

Table 15.1(b) Pipe Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Nominal Pipe Size, Schedule 40

Pipe Length (ft)	½ in. 0.622	¾ in. 0.824	1 in. 1.049	1¼ in. 1.380	1½ in. 1.610	2 in. 2.067	3 in. 3.068	3½ in. 3.548	4 in. 4.026
10	2687	5619	10585	21731	32560	62708	176687	258696	360385
20	1847	3862	7275	14936	22378	43099	121436	177800	247690
30	1483	3101	5842	11994	17971	34610	97517	142780	198904
40	1269	2654	5000	10265	15381	29621	83462	122201	170236
50	1125	2352	4431	9098	13632	26253	73971	108305	150877
60	1019	2131	4015	8243	12351	23787	67023	98132	136706
70	938	1961	3694	7584	11363	21884	61660	90280	125767
80	872	1824	3436	7055	10571	20359	57363	83988	117002
90	819	1712	3224	6620	9918	19102	53822	78803	109779
100	773	1617	3046	6253	9369	18043	50840	74437	103697
150	621	1298	2446	5021	7524	14490	40826	59776	83272
200	531	1111	2093	4298	6439	12401	34942	51160	71270
250	471	985	1855	3809	5707	10991	30968	45342	63166
300	427	892	1681	3451	5171	9959	28060	41083	57233
350	393	821	1546	3175	4757	9162	25814	37796	52653
400	365	764	1439	2954	4426	8523	24015	35162	48984
450	343	717	1350	2771	4152	7997	22533	32991	45960
500	324	677	1275	2618	3922	7554	21284	31164	43413
600	293	613	1155	2372	3554	6844	19285	28236	39336
700	270	564	1063	2182	3270	6297	17742	25977	36188
800	251	525	989	2030	3042	5858	16506	24167	33666
900	236	493	928	1905	2854	5496	15487	22675	31588
1000	222	465	876	1799	2696	5192	14629	21419	29838
1500	179	374	704	1445	2165	4169	11747	17200	23961
2000	153	320	602	1237	1853	3568	10054	14721	20507

Note: Maximum undiluted propane capacities listed are based on a 2-psig setting and a 1-psi pressure drop. Capacities in 1000 Btu/hr.

Table 15.1(c) Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 40

Pipe Length (ft)	½ in. 0.622	¾ in. 0.824	1 in. 1.049	1¼ in. 1.38	1½ in. 1.61	2 in. 2.067	3 in. 3.068	3½ in. 3.548	4 in. 4.026
10	291	608	1146	2353	3525	6789	19130	28008	39018
20	200	418	788	1617	2423	4666	13148	19250	26817
30	161	336	632	1299	1946	3747	10558	15458	21535
40	137	287	541	1111	1665	3207	9036	13230	18431
50	122	255	480	985	1476	2842	8009	11726	16335
60	110	231	435	892	1337	2575	7256	10625	14801
80	94	198	372	764	1144	2204	6211	9093	12668
100	84	175	330	677	1014	1954	5504	8059	11227
125	74	155	292	600	899	1731	4878	7143	9950
150	67	141	265	544	815	1569	4420	6472	9016
200	58	120	227	465	697	1343	3783	5539	7716
250	51	107	201	412	618	1190	3353	4909	6839
300	46	97	182	374	560	1078	3038	4448	6196
350	43	89	167	344	515	992	2795	4092	5701
400	40	83	156	320	479	923	2600	3807	5303

Note: Maximum undiluted propane capacities listed are based on 11 in w.c. setting and 0.5 in pressure drop. Capacities in 1000 Btu/hr.

tion should utilize the system employed by the listing organization to identify a listed product.

A.3.3.10 Bulk Plant. Bulk plants receive gas through a variety of methods, such as railroad tank car, transport, cargo tank vehicle, gas piping, or watercraft. These plants are generally

utilized for domestic, commercial, agricultural, institutional, and industrial applications, or for the storage of product awaiting delivery to the end user. A facility that transfers LP-Gas from railroad tank cars from a private track directly into cargo tank vehicles is also in this category. Such plants could

Table 15.1(d) Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 80

Pipe Length (ft)	½ in. 0.546	¾ in. 0.742	1 in. 0.957	1¼ in. 1.278	1½ in. 1.5	2 in. 1.939	3 in. 2.9	3½ in. 3.364	4 in. 3.826
30	1309	2927	5706	12185	18548	36368	104539	154295	216246
40	1121	2505	4884	10429	15875	31127	89472	132057	185079
50	993	2221	4328	9243	14069	27587	79297	117039	164032
60	900	2012	3922	8375	12748	24996	71849	106046	148625
70	828	1851	3608	7705	11728	22996	66100	97561	136733
80	770	1722	3357	7168	10911	21393	61494	90762	127204
90	723	1616	3149	6725	10237	20073	57697	85159	119351
100	683	1526	2975	6353	9670	18960	54501	80440	112738
150	548	1226	2389	5105	7765	15236	43766	64596	90533
200	469	1049	2045	4366	6646	13031	37458	55286	77484
250	416	930	1812	3870	5890	11549	33198	48999	68673
300	377	842	1642	3506	5337	10465	30080	44397	62223
350	347	775	1511	3226	4910	9627	27673	40844	57244
400	322	721	1405	3001	4568	8956	25745	37998	53255
450	303	676	1318	2816	4286	8403	24155	35652	49967
500	286	639	1245	2660	4048	7938	22817	33677	47199
600	259	579	1128	2410	3668	7192	20674	30514	42765
700	238	533	1038	2217	3375	6617	19020	28072	39344
800	222	495	966	2062	3139	6156	17694	26116	36602
900	208	465	906	1935	2946	5776	16602	24504	34342
1000	196	439	856	1828	2782	5456	15682	23146	32439
1500	158	353	687	1468	2234	4381	12593	18587	26050
2000	135	302	588	1256	1912	3750	10778	15908	22295

Notes:

(1) Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

(2) To convert to capacities at a gauge pressure of 5 psi with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

Table 15.1(e) Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 80

Pipe Length (ft)	½ in. 0.546	¾ in. 0.742	1 in. 0.957	1¼ in. 1.278	1½ in. 1.5	2 in. 1.939	3 in. 2.9	3½ in. 3.364	4 in. 3.826
10	207	462	901	1924	2928	5741	16503	24357	34137
20	142	318	619	1322	2012	3946	11342	16740	23462
30	114	255	497	1062	1616	3169	9108	13443	18841
40	98	218	426	909	1383	2712	7795	11506	16125
50	87	193	377	805	1226	2404	6909	10197	14292
60	78	175	342	730	1111	2178	6260	9239	12949
80	67	150	292	625	951	1864	5358	7908	11083
100	59	133	259	553	842	1652	4748	7009	9823
125	53	118	230	491	747	1464	4208	6212	8706
150	48	107	208	444	677	1327	3813	5628	7888
200	41	91	178	380	579	1135	3264	4817	6751
250	36	81	158	337	513	1006	2892	4269	5983
300	33	73	143	305	465	912	2621	3868	5421
350	30	68	132	281	428	839	2411	3559	4987
400	28	63	122	261	398	780	2243	3311	4640

Note: Maximum undiluted propane capacities listed are based on a 11 in. w.c. setting and 0.5 in. w.c. pressure drop. Capacities in 1000 Btu/hr.

have container-filling and truck loading/unloading facilities on the premises. Normally, no persons other than the plant management or plant employees have access to these facilities.

A.3.3.22 Fire Protection. *Fire prevention* covers measures directed at avoiding the inception of fire or the escalation of an incident following the accidental or inadvertent release of LP-

Table 15.1(f) Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Copper Tubing, Type K

Tubing Length (ft)	3/8 in. 0.305	1/2 in. 0.402	5/8 in. 0.527	3/4 in. 0.652	7/8 in. 0.745
30	284	587	1193	2085	2959
40	243	502	1021	1785	2532
50	216	445	905	1582	2244
60	195	403	820	1433	2033
70	180	371	754	1319	1871
80	167	345	702	1227	1740
90	157	374	659	1151	1633
100	148	306	622	1087	1542
150	119	246	500	873	1239
200	102	210	428	747	1060
250	90	186	379	662	940
300	82	169	343	600	851
350	75	155	316	552	783
400	70	144	294	514	729
450	66	136	276	482	654
500	62	128	260	455	646
600	56	116	236	412	585
700	52	107	217	379	538
800	48	99	202	353	501
900	45	93	189	331	470
1000	43	88	179	313	444
1500	34	71	144	251	356
2000	29	60	123	215	305

Notes:

(1) Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

(2) To convert to capacities at a gauge pressure of 5 psi setting with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi setting with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

Gas. Such measures could include product control equipment and the insulation, mounding, or burial of containers.

Fire detection covers equipment that detects the presence of fire or heat either to initiate automated operation of the product control or other process equipment or to initiate local or remote alarms.

Fire suppression covers means of supplying water or other agents providing for fire control, exposure protection, or fire extinguishment. [ROP-24]

A.3.3.26 Gas-Air Mixer. A gas-air mixture normally is used in industrial or commercial facilities as a substitute for another fuel gas.

A.3.3.27.6 Slip Tube Gauge. The installation fitting for the tube is designed so that the tube can be slipped in and out of the container and so that the liquid level at the inner end of the tube can be determined by observing when the shutoff valve vents liquid.

A.3.3.36 Low Emission Transfer. Specifications for low emission transfer might be employed to comply with environmental regulations or to determine certain minimum distance requirements.

Table 15.1(g) Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type K

Tubing Length (ft)	3/8 in. 0.305	1/2 in. 0.402	5/8 in. 0.527	3/4 in. 0.652	7/8 in. 0.745
10	45	93	188	329	467
20	31	64	129	226	321
30	25	51	104	182	258
40	21	44	89	156	221
50	19	39	79	138	196
60	17	35	71	125	177
80	15	30	61	107	152
100	13	27	54	95	134
125	11	24	48	84	119
150	10	21	44	76	108
200	9	18	37	65	92
250	8	16	33	58	82
300	7	15	30	52	74
350	7	14	28	48	68
400	6	13	26	45	63

Note: Maximum undiluted propane capacities listed are based on an 11 in. w.c. setting and 0.5 in. w.c. pressure drop. Capacities in 1000 Btu/hr.

A.3.3.41 Movable Fuel Storage Tender. Movable fuel storage tenders or farm carts are basically non-highway vehicles but can occasionally be moved over public roads or highways for short distances to supply fuel for farm tractors, construction machinery, and similar equipment.

A.3.3.52 Portable Container. Portable containers, designed for transportation, include *cylinders*, *cargo tanks*, and *portable tanks*, which are defined separately in this code. Containers that are designed to be readily moved from one location of use to another but that are substantially empty of product are *portable storage containers* and are also defined separately in this code.

A.3.3.53 Portable Storage Container. Portable storage containers have legs or other supports attached or are mounted on running gear (such as trailer or semitrailer chassis), with suitable supports that can be of the fold-down type. Such supports allow them to be placed on a reasonably firm and level surface. For large-volume, limited-duration product usage (such as at construction sites and normally for 12 months or less), portable storage containers serve as permanently installed stationary containers.

A.3.3.61 Refrigerated LP-Gas.

A.3.3.62.1 Automatic Changeover Regulator. An automatic changeover regulator incorporates two inlet connections and a service-reserve indicator. The system automatically changes the LP-Gas vapor withdrawal from the designated service cylinder(s) when depleted to the designated reserve cylinder(s) without interruption of service. The service reserve indicator gives a visual indication of the cylinder(s) that is supplying the system.

A.3.3.63 Service Head Adapter. LP-gas can be refrigerated to reduce the storage pressure LP-Gas at pressures near atmospheric pressure but not exceeding 15 psig (103 kPag), which are constructed to API 620. Refrigerated LP-Gas containers

Table 15.1(h) Copper Tube Sizing Between First-Stage and Second-Stage Regulators

Tubing Length (ft)	Outside Diameter Copper Tubing, Type L					Tubing Length (ft)	Outside Diameter Copper Tubing, Type L				
	⅜ in. 0.315	½ in. 0.430	⅝ in. 0.545	¾ in. 0.666	⅞ in. 0.785		⅜ in. 0.315	½ in. 0.430	⅝ in. 0.545	¾ in. 0.666	⅞ in. 0.785
30	309	700	1303	2205	3394	350	82	185	345	584	898
40	265	599	1115	1887	2904	400	76	172	321	543	836
50	235	531	988	1672	2574	450	71	162	301	509	784
60	213	481	896	1515	2332	500	68	153	284	481	741
70	196	443	824	1394	2146	600	61	138	258	436	671
80	182	412	767	1297	1996	700	56	127	237	401	617
90	171	386	719	1217	1873	800	52	118	221	373	574
100	161	365	679	1149	1769	900	49	111	207	350	539
150	130	293	546	923	1421	1000	46	105	195	331	509
200	111	251	467	790	1216	1500	37	84	157	266	409
250	90	222	414	700	1078	2000	32	72	134	227	350
300	89	201	375	634	976						

Note: Maximum undiluted propane capacities listed are based on a pressure of 10 psig first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

are typically maintained at less than ½ psig, using a container that contains significantly less steel wall thickness than a pressurized container. Refrigerated LP-gas can also be stored in ASME containers above 15 psig (103 kPag), and this is called semi-refrigerated LP-Gas. [ROP-34]

A.3.3.66 Special Protection. Where required in this code, special protection consists of one of the following:

- (1) Applied insulating coating
- (2) Mounding
- (3) Burial
- (4) Water spray fixed systems
- (5) Fixed monitor nozzles that meet the criteria specified in this code
- (6) Any means listed for this purpose

See Section 6.25 for more information on fire protection and special protection.

A.3.3.71.5 Internal Valve. An internal valve has provision for the addition of a means of remote closure. An internal valve closes when flow through the valve exceeds its rated excess-flow capacity or when pump actuation differential pressure drops to a predetermined point.

A.3.3.71.6.1 External Pressure Relief Valve. See Figure A.3.3.71.6.1.

A.3.3.71.6.2 Flush-Type Full Internal Pressure Relief Valve. See Figure A.3.3.71.6.2.

A.3.3.71.6.3 Full Internal Pressure Relief Valve. See Figure A.3.3.71.6.3.

A.3.3.71.6.4 Internal Spring-Type Pressure Relief Valve. See Figure A.3.3.71.6.4.

A.4.2.1 It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

It is recommended that odorants be qualified as to compliance with 4.2.1 by tests or experience. Where qualifying is by tests, such tests should be certified by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.9 m³) of liquid LP-Gas has been recognized as

an effective odorant. Other odorants and quantities meeting the provisions of 4.2.1 can be used. Research on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.9 m³) of liquid LP-Gas might satisfy the requirements of 4.2.1.

NOTE: Odorant research includes *A New Look at Odorization Levels for Propane Gas*, BERC/RI-77/1, United States Energy Research and Development Administration, Technical Information Center, September 1977.

A.4.2.3 Another method of determining the presence of odorant is the stain tube test. This method involves using a small hand-held pump to draw a sample across a filled glass tube and reading the length of color change. For additional information, see GPA Standard 2188, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes*, and CAN/CGSB-3.0 No. 18.5, *Test for Ethyl Mercaptan Odorant in Propane, Field Method*. At the time of the preparation of this code, additional analytical methods were under development.

A.4.4 Examples of training programs are as follows:

- (1) The Certified Employee Training Program developed by the PERC, www.propanecouncil.org
- (2) Programs developed by propane companies
- (3) Programs developed by government entities [ROP-46]

The term *refresher* indicates that the periodic training could be less intensive than the original training, whose primary purpose is to reinforce initial training rather than repeat it.

A.4.5 To test for the presence of ammonia, allow a moderate vapor stream of the product to be tested to escape from the container. A rotary, slip tube, or fixed level gauge is a convenient vapor source. Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers. Hold the wet litmus paper in the vapor stream from the container for 30 seconds. The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE: Because the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care is required in making the test and interpreting the results. Tap water, saliva,

Table 15.1(i) Copper Tube Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Outside Diameter Copper Tubing, Type L

Tubing (O.D.)	⅜ in.	½ in.	⅝ in.	¾ in.	⅞ in.
Tubing (I.D.)	0.315	0.430	0.545	0.666	0.785
Length (ft)					
10	451	1020	1900	3215	4948
20	310	701	1306	2210	3401
30	249	563	1049	1774	2731
40	213	482	898	1519	2337
50	189	427	795	1346	2071
60	171	387	721	1219	1877
70	157	356	663	1122	1727
80	146	331	617	1044	1606
90	137	311	579	979	1507
100	130	294	547	925	1424
150	104	236	439	743	1143
200	89	202	376	636	979
250	79	179	333	563	867
300	72	162	302	511	786
350	66	149	278	470	723
400	61	139	258	437	673
450	58	130	242	410	631
500	54	123	229	387	596
600	49	111	207	351	540
700	45	102	191	323	497
800	42	95	177	300	462
900	40	89	167	282	434
1000	37	84	157	266	410
1500	30	68	126	214	329
2000	26	58	108	183	282

Note: Maximum undiluted propane capacity based on a gauge pressure setting of 2 psig and 1 psi pressure drop. Capacities in 1000 Btu/hr.

perspiration, or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results. [ROP-165]

A.4.6 The installation of safety-enhancing equipment that is not otherwise required by the code is permitted by the code. This includes any device that performs a safety-related function even though the device is designed or named to perform a required function. For example, an emergency shutoff valve (ESV) is installed in a location where it is not required to provide all the safety functions of an ESV. Even though the installer uses it to provide a specific feature that can be common to all ESVs, the code would still not require compliance with all of the ESV provisions — for example, the closing requirements described in 5.12.4.

A.5.1 The field assembly of components, subassemblies, container assemblies, or complete container systems into complete LP-Gas systems is addressed in Chapter 6. (See 3.3.37, *LP-Gas System*.)

A.5.2.1.1 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Inter-

Table 15.1(j) Copper Tube Sizing Between Single-Stage or Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type L

Tubing Length (ft)	⅜ in.	½ in.	⅝ in.	¾ in.	⅞ in.
10	49	110	206	348	536
20	34	76	141	239	368
30	27	61	114	192	296
40	23	52	97	164	253
50	20	46	86	146	224
60	19	42	78	132	203
80	16	36	67	113	174
100	14	32	59	100	154
125	12	28	52	89	137
150	11	26	48	80	124
200	10	22	41	69	106
250	9	19	36	61	94
300	8	18	33	55	85
350	7	16	30	51	78
400	7	15	28	47	73

Note: Maximum undiluted propane capacities listed are based on an 11 in. setting and a 0.5 in. w.c. drop.

state Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply and are available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, has not been authorized after July 1, 1961.

A.5.2.2.1 See CGA Publication C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, or C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders*, for further information regarding cylinder inspection.

A.5.2.4.4 ASME mobile fuel containers constructed prior to April 1, 2001, were required to have a maximum allowable working pressure (MAWP) of 250 psig (1.7 MPag).

A.5.2.5.3 Prior to December 1, 1963, ASME containers greater than 30 gal (0.11 m³) water capacity, up to and including 2000 gal (76 m³) water capacity, were not required to be equipped for filling into the vapor space of the container.

A.5.2.5.4 Containers fabricated on or before July 1, 1961, are exempt from this requirement.

A.5.2.5.5 See 5.7.8.7 for the pressure gauge requirement.

A.5.2.5.7 Containers fabricated on or before December 31, 1965, are exempt from this requirement.

A.5.2.8.2 The tare weight is the cylinder weight plus the weight of all permanently attached valves and other fittings but does not include the weight of protecting devices that are removed in order to load the cylinder.

A.5.2.8.3 Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsoidal, and others. (Refer to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases* for more information.)

Table 15.1(k) Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Refrigeration Tubing

Tubing Length (ft)	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
30	299	726	1367	2329	3394
40	256	621	1170	1993	2904
50	227	551	1037	1766	2574
60	206	499	939	1600	2332
70	189	459	864	1472	2146
80	176	427	804	1370	1996
90	165	401	754	1285	1873
100	156	378	713	1214	1769
150	125	304	572	975	1421
200	107	260	490	834	1216
250	95	230	434	739	1078
300	86	209	393	670	976
350	79	192	362	616	898
400	74	179	337	573	836
450	69	168	316	538	784
500	65	158	298	508	741
600	59	144	270	460	671
700	54	132	249	424	617
800	51	123	231	394	574
900	48	115	217	370	539
1000	45	109	205	349	509
1500	36	87	165	281	409
2000	31	75	141	240	350

Notes:

(1) Maximum undiluted propane capacities listed are based on a gauge pressure of 10 psi first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.

(2) To convert to capacities at a gauge pressure of 5 psi setting with 10 percent (0.5 psi) pressure drop, multiply values by 0.606. To convert to capacities at a gauge pressure of 15 psi setting with 10 percent (1.5 psi) pressure drop, multiply values by 1.380.

A.5.7.1.2 Materials with melting points exceeding 1500°F (816°C) include steel, ductile (nodular) iron, malleable iron, or brass, as follows:

- (1) Ductile iron should meet the requirements of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*, or equivalent and malleable iron should meet the requirements of ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*, or equivalent.
- (2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m³) water capacity or less are exempt from the minimum melting point requirement.
- (3) Cast-iron should not be used.
- (4) Nonmetallic materials should not be used for bonnets or bodies of valves or regulators.

A.5.7.3.2 Example: When the dip tube length marked on the cylinder is 3.8 in. (97 mm) use a 4.0 in. (102 mm) dip tube for the retrofit.

If the dip tube length is not marked on the cylinder, contact the manufacturer for the recommended dip tube length.

A.5.7.5.3 Containers fabricated on or before December 1, 1965, were exempt from this requirement.

Table 15.1(l) Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter of Copper Refrigeration Tubing

Tubing Length (ft)	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
10	47	115	216	368	536
20	32	79	148	253	368
30	26	63	119	203	296
40	22	54	102	174	253
50	20	48	90	154	224
60	18	43	82	139	203
80	15	37	70	119	174
100	14	33	62	106	154
125	12	29	55	94	137
150	11	26	50	85	124
200	9	23	43	73	106
250	8	20	38	64	94
300	8	18	34	58	85
350	7	17	32	54	78
400	6	16	29	50	73

Note: Maximum undiluted propane capacities listed are based on an 11 in. w.c. setting and 0.5 in. w.c. pressure drop. Capacities in 1000 Btu/hr.

A.5.7.9 Container refurbishment includes activities such as sand blasting and spray painting.

A.5.8.3 ANSI/UL 651, *Schedule 40 or 80 Rigid PVC Conduit*, listed rigid PVC electrical conduit has been designed, manufactured, and tested for use in a wide variety of operating conditions, including low temperatures and exposure to sunlight and outdoor weather. UL 651 conduit is widely available and can be purchased in hardware and electrical supply stores, where it is usually sold as electrical conduit. **[ROP-167]**

A.5.9.5 Persons joining PE pipe should be trained under the applicable joining procedure established by the manufacturer, including the following:

- (1) Appropriate training in the use of joining procedures
- (2) Making a specimen joint from pipe sections joined according to the procedures
- (3) Visually examining these joints during and after assembly

A.5.9.5(D) 49 CFR 192.281(e) states the following:

Mechanical joints — Each compression-type mechanical joint on plastic pipe must comply with the following:

- (1) The gasket material in the coupling must be compatible with the plastic.
- (2) A rigid internal tubing stiffener, other than a split tubular stiffener, must be used in conjunction with the coupling.

49 CFR 192.283(b) states the following:

Mechanical joints — Before any written procedure established under 192.273(b) is used for plastic making mechanical plastic pipe joints that are designed to withstand tensile forces, the procedure must be qualified by subjecting five specimen joints made according to the procedure to the following tensile test:

- (1) Use an apparatus for the test as specified in ASTM D 638, *Standard Test Method for Tensile Properties of Plastics* (except for conditioning).

Table 15.1(m) Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 2 psig and a Pressure Drop of 1 psi (Based on 1.52 Specific Gravity Gas)

EHD* Flow Designation	Tubing Length (ft)													
	10	25	30	40	50	75	80	110	150	200	250	300	400	500
13	426	262	238	203	181	147	140	124	101	86	77	69	60	53
15	558	347	316	271	243	196	189	169	137	118	105	96	82	72
18	927	591	540	469	420	344	333	298	245	213	191	173	151	135
19	1106	701	640	554	496	406	393	350	287	248	222	203	175	158
23	1735	1120	1027	896	806	663	643	578	477	415	373	343	298	268
25	2168	1384	1266	1100	986	809	768	703	575	501	448	411	355	319
30	4097	2560	2331	2012	1794	1457	1410	1256	1021	880	785	716	616	550
31	4720	2954	2692	2323	2072	1685	1629	1454	1182	1019	910	829	716	638

Notes:

(1) Table does not include effect of pressure drop across the line regulator. If regulator loss exceeds ½ psi (based on 13 in. w.c. outlet pressure), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator can vary with flow rate.

(2) CAUTION: Capacities shown in table can exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends or fittings shall be increased by an equivalent length of tubing according to the following equation: $L = 1.3n$ where L is additional length (ft) of tubing and n is the number of additional fittings or bends.

* EHD — equivalent hydraulic diameter— a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table 15.1(n) Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 11-in. Water Column and a Pressure Drop of 0.5-in. Water Column (Based on 1.52 Specific Gravity Gas)

EHD* Flow Designation	Tubing Length (ft)																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	72	50	39	34	30	28	23	20	19	17	15	15	14	11	9	8	8
15	99	69	55	49	42	39	33	30	26	25	23	22	20	15	14	12	11
18	181	129	104	91	82	74	64	58	53	49	45	44	41	31	28	25	23
19	211	150	121	106	94	87	74	66	60	57	52	50	47	36	33	30	26
23	355	254	208	183	164	151	131	118	107	99	94	90	85	66	60	53	50
25	426	303	248	216	192	177	153	137	126	117	109	102	98	75	69	61	57
30	744	521	422	365	325	297	256	227	207	191	178	169	159	123	112	99	90
31	863	605	490	425	379	344	297	265	241	222	208	197	186	143	129	117	107

Note: Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends or fittings shall be increased by an equivalent length of tubing to the following equation: $L = 1.3n$ where L is additional length (ft) of tubing and n is the number of additional fittings or bends.

* EHD — equivalent hydraulic diameter— a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

- (2) The specimen must be of such length that the distance between the grips of the apparatus and the end of the stiffener does not affect the joint strength.
- (3) The speed of testing is 5.0 mm (0.2 in.) per minute, plus or minus 25 percent.
- (4) Pipe specimens less than 102 mm (4 in.) in diameter are qualified if the pipe yields to an elongation less than 25 percent or failure initiates outside the joint area.
- (5) Pipe specimens 102 mm (4 in.) and larger in diameter shall be pulled until the pipe is subjected to a tensile stress equal to or greater than the maximum thermal stress that would be produced by a temperature change of 55°C (100°F) or until the pipe is pulled from the fitting. If the pipe pulls from the fitting, the lowest value of the five test results or the manufacturer's rating, whichever is lower, must be used in the design calculations for stress.
- (6) Each specimen that fails at the grips must be retested using new pipe.
- (7) Results obtained pertain only to the outside diameter and material of the pipe tested, except where testing of a heavier wall pipe is used to qualify pipe of the same material but with a lesser wall thickness.

A.5.20.6 See NFPA 1192, *Standard on Recreational Vehicles*, for additional requirements where used on recreational vehicles.

A.5.20.7 Combustion air inlets and flue gas outlets should be included in the listing of the appliance.

A.5.21.5.9 See NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, for ignition and combustion controls applicable to vaporizing burners associated with grain dryers.

Table 15.1(o) Polyethylene Plastic Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (IPS)

Plastic Pipe Length (ft)	½ in. SDR 9.33 (0.660)	¾ in. SDR 11.0 (0.860)	1 in. SDR 11.00 (1.077)	1¼ in. SDR 10.00 (1.328)	1½ in. SDR 11.00 (1.554)	2 in. SDR 11.00 (1.943)
30	2143	4292	7744	13416	20260	36402
40	1835	3673	6628	11482	17340	31155
50	1626	3256	5874	10176	15368	27612
60	1473	2950	5322	9220	13924	25019
70	1355	2714	4896	8483	12810	23017
80	1261	2525	4555	7891	11918	21413
90	1183	2369	4274	7404	11182	20091
100	1117	2238	4037	6994	10562	18978
125	990	1983	3578	6199	9361	16820
150	897	1797	3242	5616	8482	15240
175	826	1653	2983	5167	7803	14020
200	778	1539	2775	4807	7259	13043
225	721	1443	2603	4510	6811	12238
250	681	1363	2459	4260	6434	11560
275	646	1294	2336	4046	6111	10979
300	617	1235	2228	3860	5830	10474
350	567	1136	2050	3551	5363	9636
400	528	1057	1907	3304	4989	8965
450	495	992	1789	3100	4681	8411
500	468	937	1690	2928	4422	7945
600	424	849	1531	2653	4007	7199
700	390	781	1409	2441	3686	6623
800	363	726	1311	2271	3429	6161
900	340	682	1230	2131	3217	5781
1000	322	644	1162	2012	3039	5461
1500	258	517	933	1616	2441	4385
2000	221	443	798	1383	2089	3753

Notes:

- (1) Maximum undiluted propane capacities listed are based on a pressure of 10 psig first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.
- (2) Dimensions in parentheses are inside diameter.

A.6.1.1 Section 6.4 includes general provisions that are applicable to most stationary systems. Section 6.5 through Section 6.13 extend and modify Section 6.4 for systems installed for specific purposes.

A.6.1.3 This installation of safety-enhancing equipment that is not otherwise required by the code is permitted by the code. This includes any device that performs a safety-related function even though the device is designed or named to perform a required function. For example, if an emergency shutoff valve (ESV) is installed in a location where it is not required, and the installation is not intended to perform the function of an ESV but to provide a function or feature that is available in the ESV, then it is not required to comply with all of the closing requirements described in 5.12.4.

A.6.3.1 When applying Table 6.3.1 to cylinders, which have capacities in pounds, the first row, <125 gallons includes all cylinders. Cylinders have a maximum capacity of 1000 lb or 119 gallons (water capacity). [ROP-168]

A.6.4.5.3 For information on determination of flash points, see NFPA 30, *Flammable and Combustible Liquids Code*.

A.6.4.5.8 Also see NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, for oxygen systems, and NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, for gaseous hydrogen systems.

A.6.4.6 Because of the anticipated flash of some nonrefrigerated LP-Gases when released to the atmosphere, dikes normally serve no useful purpose for these nonrefrigerated installations. [ROP-169]

A.6.4.7 The presence of such structures can create significant hazards, such as the following:

- (1) Pocketing of escaping gas
- (2) Interference with application of cooling water by fire departments
- (3) Redirection of flames against containers
- (4) Impeding the egress of personnel in an emergency

A.6.5.1 It is the intent to allow transfer of liquid into containers in open areas under canopies or roofs where 50 percent or more of the perimeter is not enclosed.

A.6.6.1.4 Generally, a light reflecting color paint is preferred unless the system is installed in an extremely cold climate.

Table 15.1(p) Polyethylene Plastic Tube Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (CTS)

Plastic Tubing Length (ft)	½ in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
30	762	5225
40	653	4472
50	578	3964
60	524	3591
70	482	3304
80	448	3074
90	421	2884
100	397	2724
125	352	2414
150	319	2188
175	294	2013
200	273	1872
225	256	1757
250	242	1659
275	230	1576
300	219	1503
350	202	1383
400	188	1287
450	176	1207
500	166	1140
600	151	1033
700	139	951
800	129	884
900	121	830
1000	114	784
1500	92	629
2000	79	539

Notes:

- (1) Maximum undiluted propane capacities listed are based on 10 psig first-stage setting and 1 psi pressure drop. Capacities in 1000 Btu/hr.
- (2) Dimensions in parentheses are inside diameter.

A.6.6.6.1 See Annex K.

A.6.6.6.1(G)(2) If vapor is vented too rapidly, the pressure drop due to the refrigeration of the liquid can lead to the erroneous conclusion that no liquid remains in the container.

A.6.6.6.1(I) For information on corrosion protection of containers and piping systems, see the following:

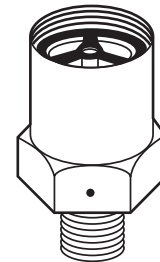
- (1) API Publication 1632, Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems, 3ed 96(R2002).
- (2) Underwriters Laboratories of Canada, CAN/ULC S603.1, Standard for External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids.
- (3) National Association of Corrosion Engineers Standard RP0169, Standard Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- (4) National Association of Corrosion Engineers Standard RP0285, Standard Recommended Practice, Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.

Table 15.1(q) Polyethylene Plastic Tube Sizing Between Second-Stage Regulator and Building: Nominal Outside Diameter (CTS)

Plastic Tubing Length (ft)	½ in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
10	121	829
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113

Notes:

- (1) Maximum undiluted propane capacities listed are based on 11 in. w.c. setting and a 0.5 in. w.c. pressure drop. Capacities in 1000 Btu/hr.
- (2) Dimensions in parentheses are inside diameter.

**FIGURE A.3.3.71.6.1 External Pressure Relief Valve.**

- (5) Underwriters Laboratories Inc., UL 1746, External Corrosion Protection Systems for Steel Underground Storage Tanks. [ROP-96][ROP-171]

A.6.6.6.1(K) Firm earth can be used.

A.6.6.6.3(1) Noncombustible, noncorrosive materials include vermiculite and perlite.

A.6.8.2(H) Two psi regulator systems operate with 2 psi (13.8 kPa) downstream of the 2 psi service regulators to the line pressure regulator, which reduces the pressure to an appropriate inches-of-water-column pressure.

A.6.9.1.1(4) Construction of buildings or separate areas of buildings housing certain internal combustion engines is covered in NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*. [ROP-172]