Appendix A

Pipe and Duct Systems

Table A.1 Average roughness of commercial pipes

	ε	
New Material	ft	mm
Riveted steel	0.003–0.03	0.9–9.0
Concrete	0.001–0.01	0.3–3.0
Wood stave	0.0006–0.003	0.18–0.9
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Asphalted cast iron	0.0004	0.12
Commercial steel	0.00015	0.046
Drawn tubing	0.000005	0.0015
Glass	"Smooth"	"Smooth"

Source: Fox, R. and McDonald, A. (1998) *Introduction to Fluid Mechanics*, 5th edn, John Wiley & Sons, Inc., New York

Introduction to Thermo-Fluids Systems Design, First Edition. André G. McDonald and Hugh L. Magande.

Table A.2 Correlation equations for friction factors

Swamee-Jain formulae	$f_o = 0.25\left[\log\left(\frac{\varepsilon/D}{3.7} + \frac{5.74}{\mathrm{Re}_D^{0.9}}\right)\right]^{-2}$
Colebrook equation	$\frac{1}{\sqrt{f}} = -2.0\log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}_D\sqrt{f}}\right)$
Haaland's approximation	$\frac{1}{\sqrt{f}} = -1.8\log\left[\frac{6.9}{\mathrm{Re}_D} + \left(\frac{\varepsilon/D}{3.7}\right)^{1.11}\right]$
Blasius correlation for smooth pipes	$f = \frac{0.316}{\mathrm{Re}_D^{0.25}}$, for $\mathrm{Re}_D \leq 10^5$
Churchill's equation	$f = 8\left[\left(\frac{8}{\mathrm{Re}_D}\right)^{12} + (A+B)^{-3/2}\right]^{1/12}$, $A = \left[2.457\ln\left(\frac{1}{C}\right)\right]^{16}$, $B = \left(\frac{37530}{\mathrm{Re}_D}\right)^{16}$, $C = \left(\frac{7}{\mathrm{Re}_D}\right)^{0.9} + 0.27\left(\frac{\varepsilon}{D}\right)$
First Petukhov equation for turbulent flow in smooth tubes	$f = [0.79\ln\mathrm{Re} - 1.64]^{-2}$, for $3000 < \mathrm{Re} < 5 \times 10^6$

Table A.3 Circular equivalents of rectangular ducts for equal friction and capacity

	Diameter of Circular Duct																
y / x	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24
6	6.6																
7	7.1	7.7															
8	7.5	8.2	8.8														
9	8.0	8.6	9.3	9.9													
10	8.4	9.1	9.8	10.4	10.9												
11	8.8	9.5	10.2	10.8	11.4	12.0											
12	9.1	9.9	10.7	11.3	11.9	12.5	13.1										
13	9.5	10.3	11.1	11.8	12.4	13.0	13.6	14.2									
14	9.8	10.7	11.5	12.2	12.9	13.5	14.2	14.7	15.3								
15	10.1	11.0	11.8	12.6	13.3	14.0	14.6	15.3	15.8	16.4							
16	10.4	11.4	12.2	13.0	13.7	14.4	15.1	15.7	16.3	16.9	17.5						
17	10.7	11.7	12.5	13.4	14.1	14.9	15.5	16.1	16.8	17.4	18.0	18.6					
18	11.0	11.9	12.9	13.7	14.5	15.3	16.0	16.6	17.3	17.9	18.5	19.1	19.7				
19	11.2	12.2	13.2	14.1	14.9	15.6	16.4	17.1	17.8	18.4	19.0	19.6	20.2	20.8			
20	11.5	12.5	13.5	14.4	15.2	15.9	16.8	17.5	18.2	18.8	19.5	20.1	20.7	21.3	21.9		
22	12.0	13.1	14.1	15.0	15.9	16.7	17.6	18.3	19.1	19.7	20.4	21.0	21.7	22.3	22.9	24.1	
24	12.4	13.6	14.6	15.6	16.6	17.5	18.3	19.1	19.8	20.6	21.3	21.9	22.6	23.2	23.9	25.1	26.2
26	12.8	14.1	15.2	16.2	17.2	18.1	19.0	19.8	20.6	21.4	22.1	22.8	23.5	24.1	24.8	26.1	27.2
28	13.2	14.5	15.6	16.7	17.7	18.7	19.6	20.5	21.3	22.1	22.9	23.6	24.4	25.0	25.7	27.1	28.2
30	13.6	14.9	16.1	17.2	18.3	19.3	20.2	21.1	22.0	22.9	23.7	24.4	25.2	25.9	26.7	28.0	29.3
32	14.0	15.3	16.5	17.7	18.8	19.8	20.8	21.8	22.7	23.6	24.4	25.2	26.0	26.7	27.5	28.9	30.1
34	14.4	15.7	17.0	18.2	19.3	20.4	21.4	22.4	23.3	24.2	25.1	25.9	26.7	27.5	28.3	29.7	31.0
36	14.7	16.1	17.4	18.6	19.8	20.9	21.9	23.0	23.9	24.8	25.8	26.6	27.4	28.3	29.0	30.5	32.0
38	15.0	16.4	17.8	19.0	20.3	21.4	22.5	23.5	24.5	25.4	26.4	27.3	28.1	29.0	29.8	31.4	32.8
40	15.3	16.8	18.2	19.4	20.7	21.9	23.0	24.0	25.1	26.0	27.0	27.9	28.8	29.7	30.5	32.1	33.6

Dimensions in inches, feet, or meters.

Table A.4 Approximate equivalent lengths for selected fittings in circular ducts

	Equivalent Length (ft)					
Fitting	Diameter (in.)	6	8	10	12	
Elbows						L_e/D
Pleated, 90°		8	10	13	15	15
Pleated, 45°		5	6	8	9	9
Mitered, 90°		30	40	50	60	60
Mitered with vanes		5	7	8	10	10
Transitions						
Converging, 20°		2	3	3	4	4
Diverging, 120°		20	27	33	40	40
Abrupt expansion		30	40	50	60	60
Round to rectangular boot, 90°		25	33	40	50	50
Round to rectangular boot, straight		5	7	8	10	10
Entrances						
Abrupt, 90°		15	20	25	30	30
Bellmouth		6	8	10	12	12
Branch fittings, diverging						
Wye, 45°, branch		10	13	17	20	20
Wye, 45°, through		4	5	7	8	8
Tee, branch		20	27	33	40	40
Tee, through		4	5	7	8	8
Branch fittings, converging						
Wye, 45°, branch		10	13	17	20	20
Wye, 45°, through		5	7	8	10	10
Tee, branch		20	27	33	40	40
Tee, through		6	8	10	12	12

Source: McQuiston, F., Parker, J., and Spitler, J. (2000) *Heating, Ventilating, and Air Conditioning: Analysis and Design*, 5th edn, John Wiley & Sons, Inc., New York, p. 433.

Table A.5 Approximate equivalent lengths for elbows in ducts

	Equivalent Length (ft)					
Fitting	Diameter (in.)	6	8	10	12	
Elbows $R/D = 1.5$						L_e/D
Smooth, 90°		4.5	6	–	–	9
5-piece, 90°		6	8	10	12	12
3-piece, 90°		12	16	20	24	24
Smooth, 45°		2.3	3	–	–	4.5
3-piece, 45°		3	4	5	6	6

Source: *System Design Manual, Part 2*: Air Distribution, Carrier Air Conditioning Co., Syracuse, NY, 1974.

Table A.6 Data for copper pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
Copper					
Type L	1/4	0.315	0.375	0.16	0.004
Type L	3/8	0.430	0.500	0.26	0.008
Type L	1/2	0.545	0.625	0.39	0.012
Type L	5/8	0.666	0.750	0.512	0.018
Type L	3/4	0.785	0.875	0.67	0.025
Type L	1	1.025	1.125	1.01	0.043
Type L	1 1/4	1.265	1.375	1.43	0.065
Type L	1 1/2	1.505	1.625	1.91	0.093
Type L	2	1.985	2.125	3.09	0.161
Type L	2 1/2	2.465	2.625	4.55	0.248
Type L	3	2.945	3.125	6.29	0.354
Type L	3 1/2	3.425	3.625	8.29	0.479
Type L	4	3.905	4.125	10.58	0.622
Type L	5	4.875	5.125	15.70	0.970
Type L	6	5.845	6.125	21.81	1.394
Type L	8	7.725	8.125	39.58	2.435
Type L	10	9.625	10.125	61.61	3.780
Type L	12	11.565	12.125	85.89	5.457
Type K	1/4	0.305	0.375	0.177	0.004
Type K	3/8	0.402	0.500	0.275	0.007
Type K	1/2	0.527	0.625	0.438	0.011
Type K	5/8	0.652	0.750	0.563	0.017
Type K	3/4	0.745	0.875	0.829	0.023
Type K	1	0.995	1.125	1.176	0.040
Type K	1 1/4	1.245	1.375	1.570	0.063
Type K	1 1/2	1.481	1.625	2.109	0.089
Type K	2	1.959	2.125	3.364	0.157
Type K	2 1/2	2.435	2.625	4.927	0.242
Type K	3	2.907	3.125	6.870	0.345
Type K	3 1/2	3.385	3.625	9.051	0.467
Type K	4	3.857	4.125	11.564	0.607
Type K	5	4.805	5.125	17.532	0.942
Type K	6	5.741	6.125	25.132	1.345
Type K	8	7.583	8.125	45.494	2.346
Type K	10	9.449	10.125	70.689	3.643
Type K	12	11.315	12.125	101.355	5.224

Table A.7 Data for schedule 40 steel pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
Steel					
Schedule 40	1/4	0.364	0.540	0.475	0.005
Schedule 40	3/8	0.493	0.675	0.647	0.010
Schedule 40	1/2	0.622	0.840	0.992	0.016
Schedule 40	3/4	0.824	1.050	1.372	0.028
Schedule 40	1	1.049	1.315	2.055	0.045
Schedule 40	1 1/4	1.380	1.660	2.929	0.077
Schedule 40	1 1/2	1.610	1.900	3.602	0.106
Schedule 40	2	2.067	2.375	5.114	0.174
Schedule 40	2 1/2	2.469	2.875	7.873	0.248
Schedule 40	3	3.068	3.500	10.781	0.383
Schedule 40	3 1/2	3.548	4.000	13.397	0.513
Schedule 40	4	4.026	4.500	16.316	0.660
Schedule 40	5	5.047	5.563	23.280	1.039
Schedule 40	6	6.065	6.625	31.490	1.501
Schedule 40	8	7.981	8.625	47.150	2.599
Schedule 40	10	10.020	10.750	74.600	4.096
Schedule 40	12	11.938	12.750	102.100	5.815
Schedule 40	14	13.126	14.000	121.870	7.029
Schedule 40	16	15.000	16.000	159.500	9.180
Schedule 40	18	16.874	18.000	202.200	11.617
Schedule 40	20	18.814	20.000	243.400	14.442
Schedule 40	24	22.626	24.000	345.200	20.887

Table A.8 Data for schedule 80 steel pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
Steel					
Schedule 80	3/8	0.423	0.675	0.798	0.007
Schedule 80	1/2	0.546	0.840	1.189	0.012
Schedule 80	3/4	0.742	1.050	1.686	0.026
Schedule 80	1	0.957	1.315	2.483	0.037
Schedule 80	1 1/4	1.278	1.660	3.551	0.067
Schedule 80	1 1/2	1.500	1.900	4.396	0.092
Schedule 80	2	1.939	2.375	6.302	0.154
Schedule 80	2 1/2	2.323	2.875	9.491	0.220
Schedule 80	3	2.900	3.500	13.122	0.344
Schedule 80	3 1/2	3.364	4.000	16.225	0.458
Schedule 80	4	3.826	4.500	19.953	0.597
Schedule 80	5	4.813	5.563	28.650	0.945
Schedule 80	6	5.761	6.625	39.860	1.354
Schedule 80	8	7.625	8.625	63.200	2.372
Schedule 80	10	9.564	10.750	95.840	3.732
Schedule 80	12	11.376	12.750	132.600	5.280
Schedule 80	14	12.500	14.000	158.200	6.375
Schedule 80	16	14.314	16.000	206.700	8.360
Schedule 80	18	16.126	18.000	259.500	10.610
Schedule 80	20	17.938	20.000	318.400	13.128
Schedule 80	24	21.564	24.000	455.200	18.972

Table A.9 Data for class 150 cast iron pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
Cast Iron					
Class 150	3	3.32	3.96	15.92	0.450
Class 150	4	4.10	4.80	21.97	0.686
Class 150	6	6.14	6.90	38.43	1.538
Class 150	8	8.23	9.05	59.66	2.763
Class 150	10	10.22	11.10	73.94	4.261
Class 150	12	12.24	13.20	113.82	6.113
Class 150	14	14.28	15.30	148.05	8.320
Class 150	16	16.32	17.40	185.30	10.867
Class 150	18	18.34	19.50	228.69	13.723
Class 150	20	20.36	21.60	277.44	16.913
Class 150	24	24.34	25.80	391.31	24.171
Class 150	30	30.30	32.00	589.19	37.458
Class 150	36	36.42	38.30	814.90	54.118
Class 150	42	42.40	44.50	1087.30	73.348
Class 150	48	48.52	50.80	1392.60	96.051

Table A.10 Data for glass pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
Glass					
Regular Schedule	1½	1.60	1.84	0.89	0.104
Regular Schedule	2	2.06	2.34	1.45	0.173
Regular Schedule	3	3.07	3.41	3.19	0.385
Regular Schedule	4	4.13	4.53	5.79	0.696
Regular Schedule	6	6.18	6.66	12.78	1.558
Heavy Schedule	1	1.00	1.31	0.95	0.041
Heavy Schedule	1½	1.50	1.84	1.63	0.092
Heavy Schedule	2	2.00	2.34	2.46	0.163
Heavy Schedule	3	3.00	3.41	5.06	0.367
Heavy Schedule	4	4.00	4.53		
Heavy Schedule	6	6.00	6.66		

Table A.11 Data for PVC plastic pipes

Material	Diameter (in.)			Weight per Linear Foot of Pipe and Water (lb)	Gallons of Water per Linear Foot
	Nominal	Inner	Outer		
PVC Plastic					
Schedule 40	1/8	0.269	0.405	0.068	0.003
Schedule 40	1/4	0.364	0.540	0.119	0.005
Schedule 40	3/8	0.493	0.675	0.183	0.010
Schedule 40	1/2	0.622	0.840	0.282	0.016
Schedule 40	3/4	0.784	1.050	0.429	0.025
Schedule 40	1	1.049	1.315	0.669	0.045
Schedule 40	1 1/4	1.380	1.660	1.047	0.078
Schedule 40	1 1/2	1.610	1.900	1.360	0.106
Schedule 40	2	2.067	2.375	2.095	0.174
Schedule 40	2 1/2	2.469	2.875	3.092	0.249
Schedule 40	3	3.068	3.500	4.533	0.384
Schedule 40	3 1/2	3.548	4.000	5.878	0.514
Schedule 40	4	4.026	4.500	7.409	0.661
Schedule 40	5	5.047	5.563	11.430	1.039
Schedule 40	6	6.065	6.625	15.489	1.501
Schedule 40	8	7.981	8.625	26.880	2.599
Schedule 40	10	10.018	10.750	41.605	4.095
Schedule 40	12	11.938	12.750	58.523	5.815
Schedule 80	1/8	0.215	0.405	0.071	0.002
Schedule 80	1/4	0.302	0.540	0.125	0.004
Schedule 80	3/8	0.423	0.675	0.190	0.007
Schedule 80	1/2	0.546	0.840	0.251	0.012
Schedule 80	3/4	0.742	1.050	0.481	0.022
Schedule 80	1	0.957	1.315	0.693	0.037
Schedule 80	1 1/4	1.278	1.660	1.082	0.067
Schedule 80	1 1/2	1.500	1.900	1.404	0.092
Schedule 80	2	1.939	2.375	2.163	0.153
Schedule 80	2 1/2	2.323	2.875	3.184	0.220
Schedule 80	3	2.900	3.500	4.664	0.343
Schedule 80	3 1/2	3.364	4.000	6.045	0.462
Schedule 80	4	3.826	4.500	7.616	0.597
Schedule 80	5	4.780	5.563	11.996	0.932
Schedule 80	6	5.761	6.625	16.318	1.354
Schedule 80	8	7.625	8.625	27.823	2.372
Schedule 80	10	9.564	10.750	42.994	3.732
Schedule 80	12	11.376	12.750	60.365	5.280

Source: Some data from Erico International Corp., *Pipe Hanger and Support Recommended Specifications*, Erico Corp., Solon, OH, 2010, pp. 114–117.

Table A.12 Typical average velocities for selected pipe flows[a]

Fluid	Application	Velocity (fps)	Velocity (m/s)
Steam	Superheated process steam	148–328	45–100
	Auxiliary heat steam	98–246	30–75
	Saturated and low-pressure steam	98–164	30–50
Water	Centrifugal pump suction lines	3–4.9 (must be <4.9 fps)[b]	0.9–1.5 (must be < 1.5 m/s)[b]
	Power plant feedwater	7.9–15	2.4–4.6
	General building service	3.9–10.2	1.2–3.1
	Potable water	Up to 6.9 (must be <9.8 fps)[b]	Up to 2.1 (must be <3.0 m/s)[b]

[a] Adapted from the US Department of the Army, TM 5-810-15, Central Boiler Plants, August 1995.
[b] Adapted from *2005 Fundamentals* American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, GA, 2005, pp. 36–11.

Table A.13 Erosion limits: maximum design fluid velocities for water flow in small tubes

Low carbon steel	10 ft/s
Stainless steel	15 ft/s
Aluminum	6 ft/s
Copper	6 ft/s
90–10 Cupronickel	10 ft/s
70–30 Cupronickel	15 ft/s
Titanium	50 ft/s
For other liquids	$V_{\text{liq,max}} = V_{\text{water,max}} \left[\frac{\rho_{\text{water}}}{\rho_{\text{liq}}} \right]$
For gases and dry vapors (ft/s), where M = molecular weight	$V_{\text{gas,max}} = \frac{1800}{\sqrt{PM}}$

Source: Adapted from Wolverine Tube Inc., *Wolverine Tube Heat Transfer Data Book*, Wolverine Tube Inc., Huntsville, AL, 2009, p. 48.

Table A.14 Loss coefficients for pipe fittings

	Screwed				Flanged				
Nominal Diameter (in.)	½	1	2	4	1	2	4	8	20
Valves (FO)									
Globe	14	8.2	6.9	5.7	13	8.5	6.0	5.8	5.5
Gate	0.30	0.24	0.16	0.11	0.80	0.35	0.16	0.07	0.03
Swing check	5.1	2.9	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Angle	9.0	4.7	2.0	1.0	4.5	2.4	2.0	2.0	2.0
Ball valve[a]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Gate valve[a]	¼C	½ C	¾ C						
	0.3	2.1	17						
Foot valve with strainer[a,b]	Poppet disk	Hinged disk							
	7	1.25							
Elbows									
45° regular	0.39	0.32	0.30	0.29					
45° long radius					0.21	0.20	0.19	0.16	0.14
90° regular	2.0	1.5	0.95	0.64	0.50	0.39	0.30	0.26	0.21
90° long radius	1.0	0.72	0.41	0.23	0.40	0.30	0.19	0.15	0.10
180° regular	2.0	1.5	0.95	0.64	0.41	0.35	0.30	0.25	0.20
180° long radius					0.40	0.30	0.21	0.15	0.10
Tees									
Line flow	0.90	0.90	0.90	0.90	0.24	0.19	0.14	0.10	0.07
Branch flow	2.4	1.8	1.4	1.1	1.0	0.80	0.64	0.58	0.41
Expansion[c]	*d/D*	*d/D*	*d/D*	*d/D*					
	0.2	0.4	0.6	0.8					
$K_{expansion}$	0.30	0.25	0.15	0.10					
Contraction[c]**:**	60° contraction angle								
	0.07								

[c] *Source*: Çengel, Y. and Cimbala, J. (2009) *Fluid Mechanics: Fundamentals and Applications*, 2nd edn., New York.

FO, fully open; C, closed.

[a] These are representative loss coefficient values. Consult manufacturer's data for final design values.

[b] Values estimated with data from: Flow of fluids through valves, fittings, and pipe, Technical Paper No. 410, Crane Company, New York, 1982.

Table A.15 Typical pipe data format

Pipe Data							
Pipe Section No.	Pipe Length (ft)	Flow Rate (gpm)	Lost Head (ft/100 ft)	Fluid Velocity (ft/s)	Nominal Size (in.)	Minor Losses (ft)	Total Head Loss (ft)

Table A.16 Typical pump schedule format

Pump Schedule									
				Fluid			Electrical		
Tag	Manufacturer and Model Number	Type	Construction	Flow Rate (gpm)	Working Fluid	Head Loss (ft)	Motor Size (hp)	Motor Speed (rpm)	Volt/ pH/ Hz

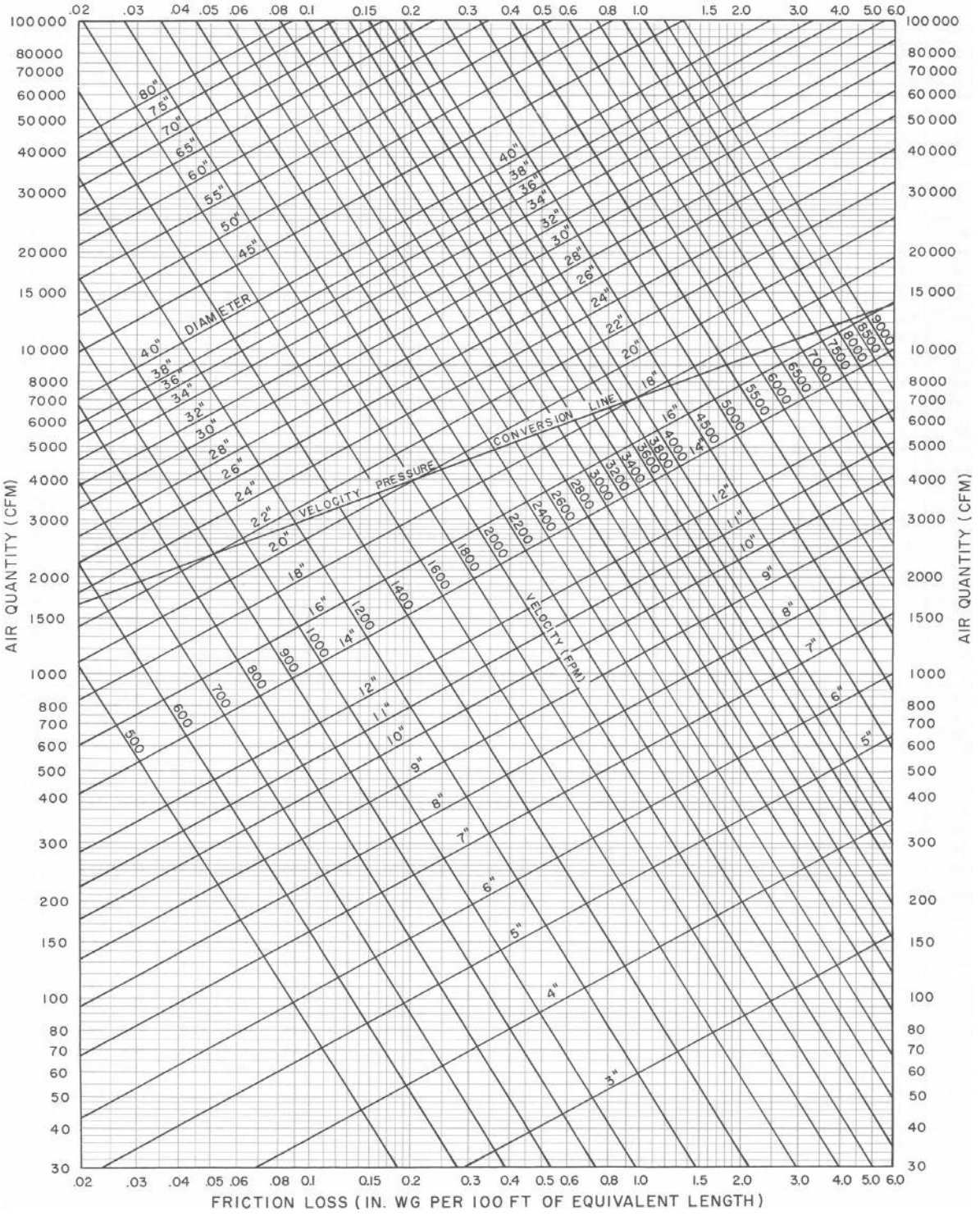

Figure A.1 Friction Loss in Round (Straight) Ducts. *Source: System Design Manual, Part 2: Air Distribution*, Carrier Air Conditioning Co., Syracuse, NY, 1974 (Reprinted with permission)

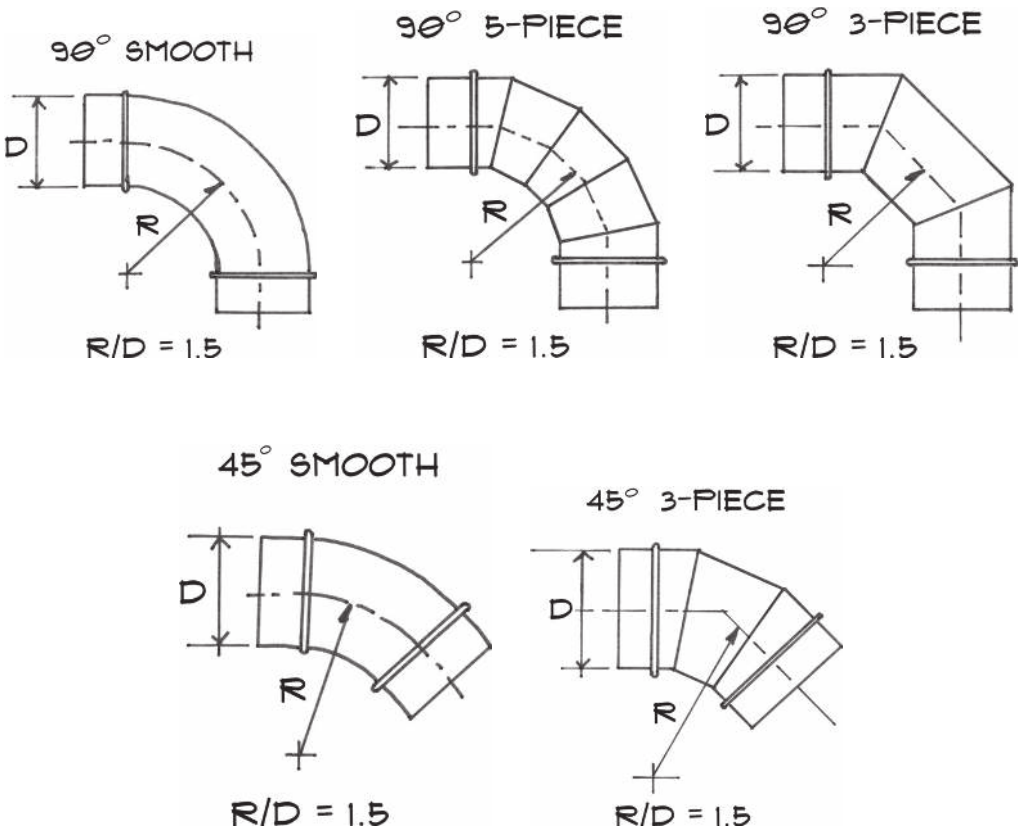

Figure A.2 Schematics elbows in ducts

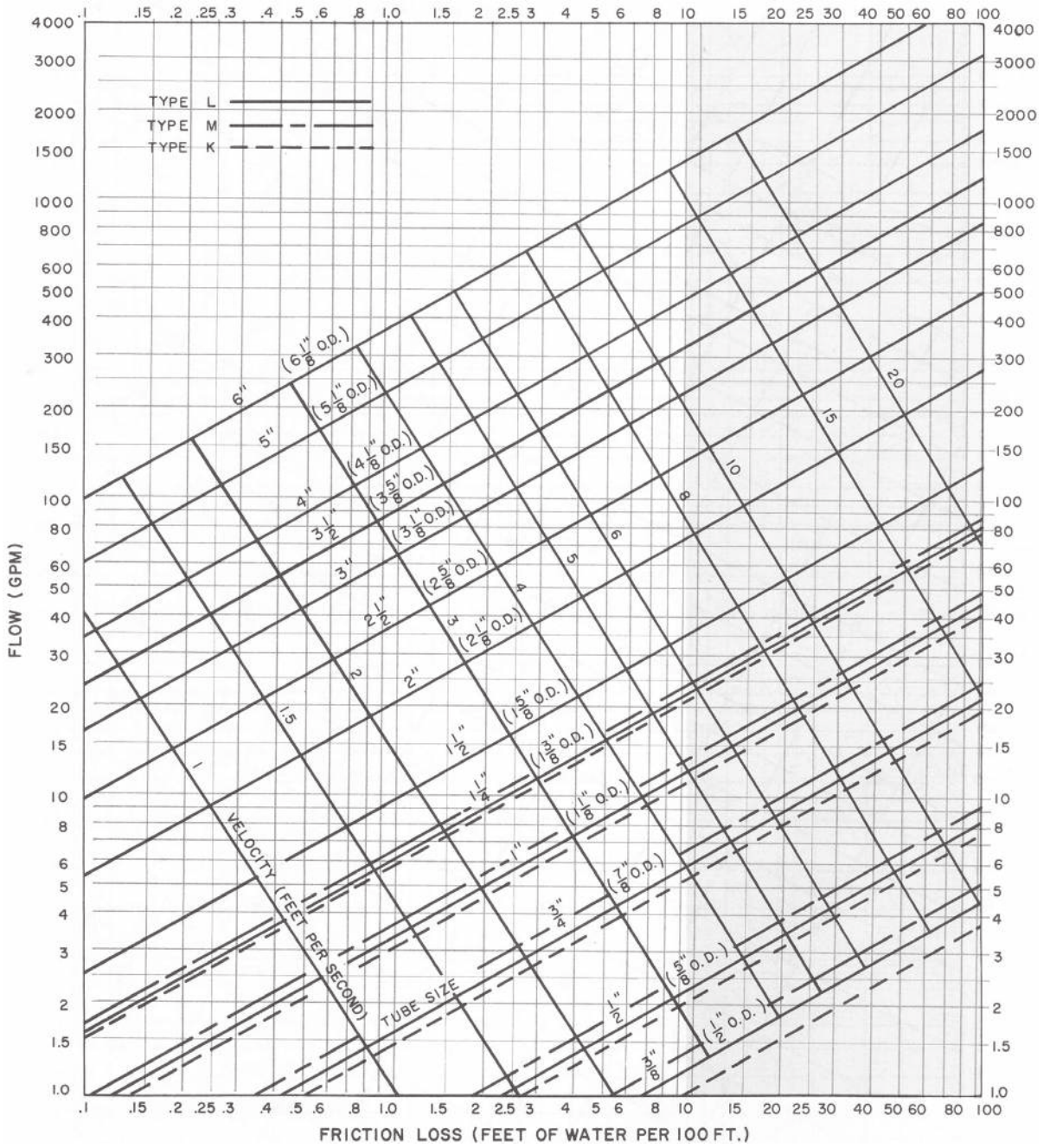

Figure A.3 Copper tubing friction loss (open and closed piping systems) (Carrier Corp.; reprinted with permission)

(*a*) Open Piping Systems

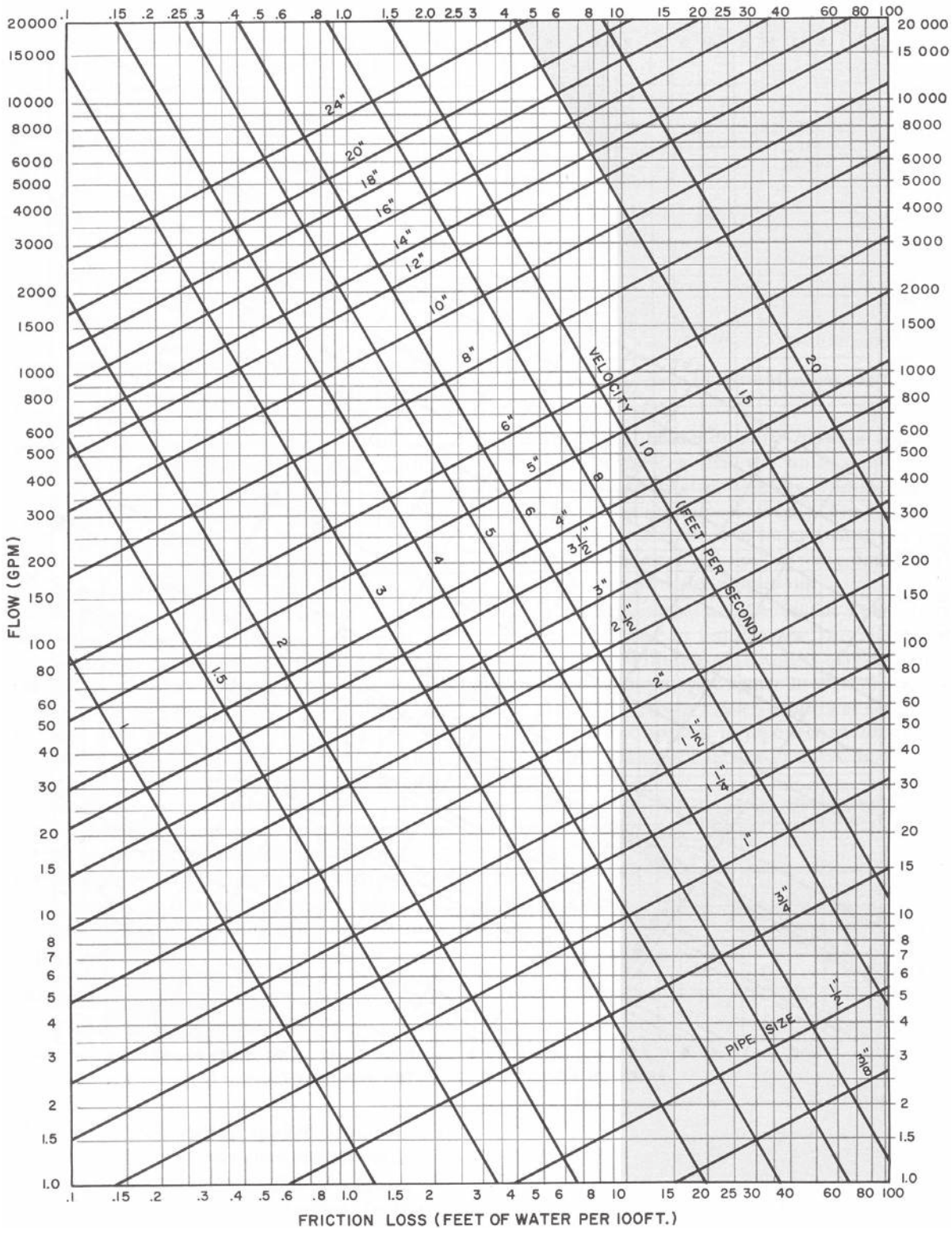

Figure A.4 Commercial steel pipe (Schedule 40) friction loss. (a) *Open piping systems* (Carrier Corp.; reprinted with permission); (b) *closed piping systems* (Carrier Corp.; reprinted with permission)

(*b*) Closed Piping Systems

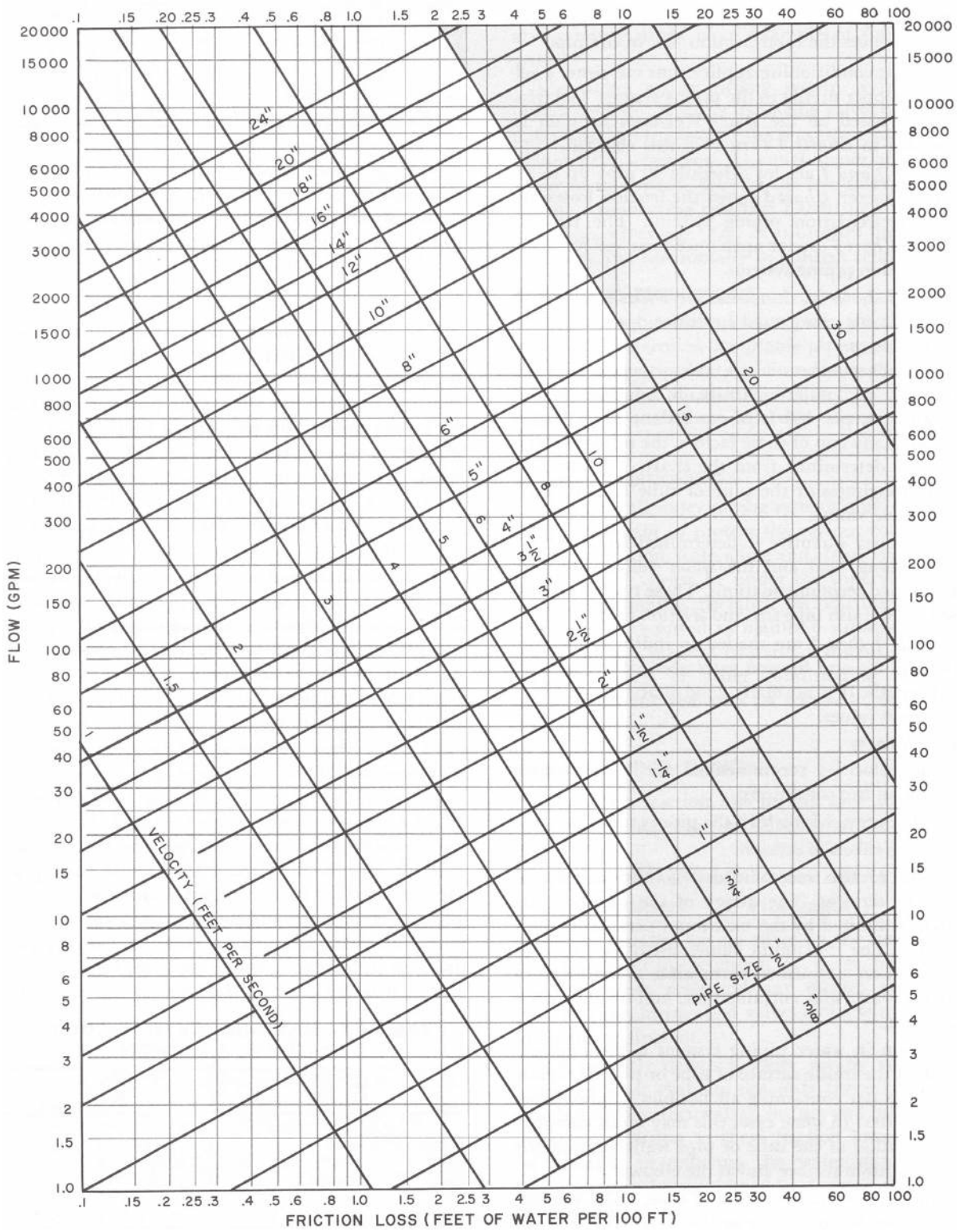

Figure A.4 (*Continued*)

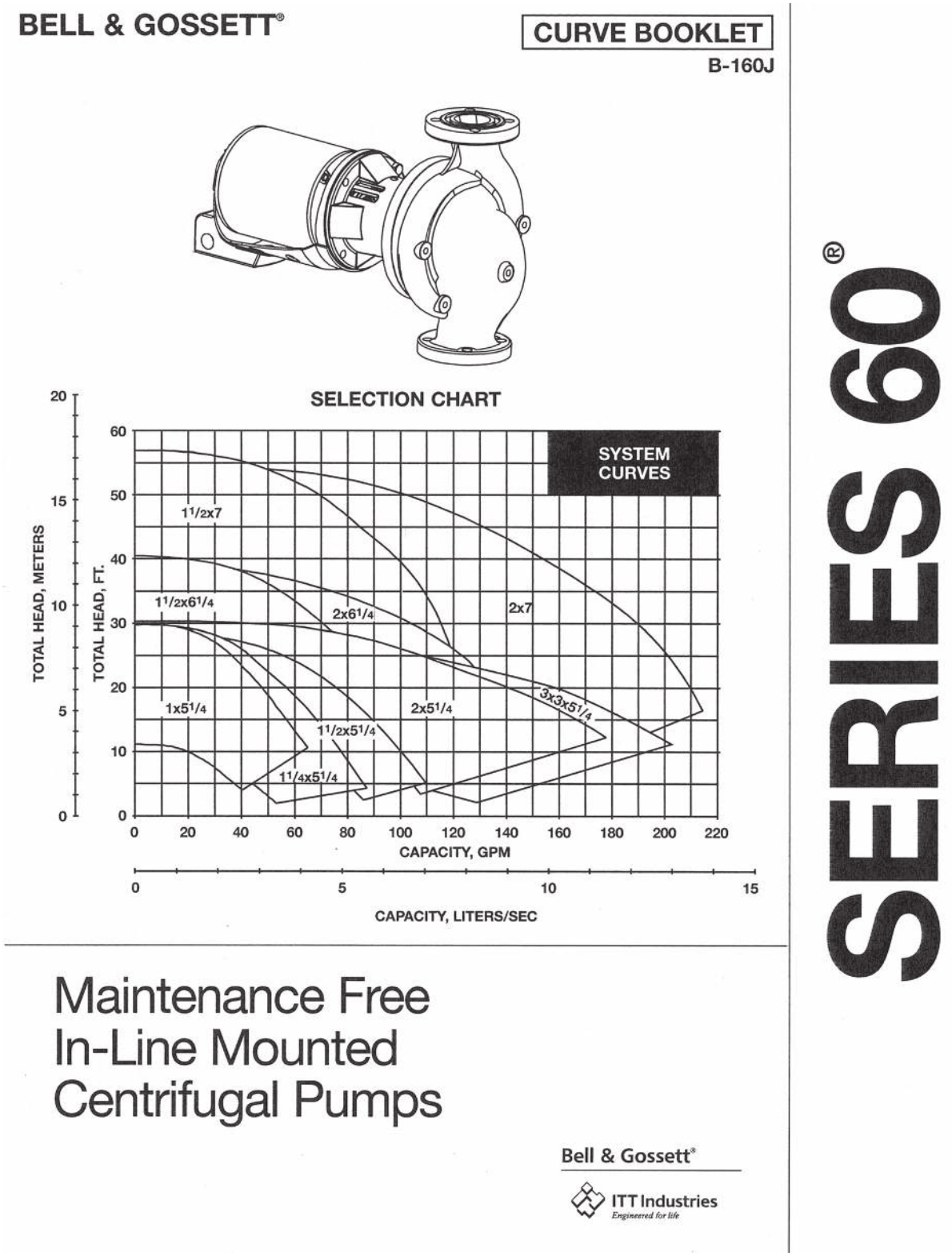

Figure A.5 Bell & Gosset pump catalog (ITT Bell & Gossett; reprinted with permission)

SERIES 60 STOCK PUMPS

BRONZE FITTED CONSTRUCTION

SINGLE PHASE UNITS

PART #	MODEL	PUMP SIZE	MOTOR HP	IMPELLER DIA.
172701	601S	1x1x5 1/4	1/4	4.38"
172702	602S	1x1x5 1/4	1/3	4.84"
172703	603S	1x1x5 1/4	1/2	5.25"
172707	604S	1 1/4x1 1/4x5 1/4	1/4	4.38"
172708	605S	1 1/4x1 1/4x5 1/4	1/3	4.84"
172667	606S	1 1/4x1 1/4x5 1/4	1/2	5.25"
172712	607S	1 1/2x1 1/2x5 1/4	1/3	4.38"
172713	608S	1 1/2x1 1/2x5 1/4	1/2	4.94"
172668	609S	1 1/2x1 1/2x5 1/4	3/4	5.25"
172717	610S	2x2x5 1/4	1/2	4.12"
172718	611S	2x2x5 1/4	3/4	4.75"
172669	612S	2x2x5 1/4	1	5.25"
172755	621S	1 1/2x1 1/2x6 1/4	1/2	4.88"
172722	613S	1 1/2x1 1/2x6 1/4	3/4	5.75"
172670	614S	1 1/2x1 1/2x6 1/4	1	6.25"
172723	615S	2x2x6 1/4	3/4	5.62"
172671	616S	2x2x6 1/4	1	6.22"
172757	622S	1 1/2x1 1/2x7	3/4	5.50"
172758	623S	1 1/2x1 1/2x7	1	6.00"
172724	617S	1 1/2x1 1/2x7	1 1/2	6.50"
172761	624S	2x2x7	1	5.69"
172762	625S	2x2x7	1 1/2	6.12"

THREE PHASE UNITS

PART #	MODEL	PUMP SIZE	MOTOR HP	IMPELLER DIA.
172725	601T	1x1x5 1/4	1/4	4.38"
172726	602T	1x1x5 1/4	1/3	4.84"
172727	603T	1x1x5 1/4	1/2	5.25"
172731	604T	1 1/4x1 1/4x5 1/4	1/4	4.38"
172732	605T	1 1/4x1 1/4x5 1/4	1/3	4.84"
172733	606T	1 1/4x1 1/4x5 1/4	1/2	5.25"
172737	607T	1 1/2x1 1/2x5 1/4	1/3	4.38"
172738	608T	1 1/2x1 1/2x5 1/4	1/2	4.94"
172739	609T	1 1/2x1 1/2x5 1/4	3/4	5.25"
172743	610T	2x2x5 1/4	1/2	4.12"
172744	611T	2x2x5 1/4	3/4	4.75"
172745	612T	2x2x5 1/4	1	5.25"
172756	621T	1 1/2x1 1/2x6 1/4	1/2	4.88"
172749	613T	1 1/2x1 1/2x6 1/4	3/4	5.75"
172750	614T	1 1/2x1 1/2x6 1/4	1	6.25"
172751	615T	2x2x6 1/4	3/4	5.62"
172752	616T	2x2x6 1/4	1	6.22"
172759	622T	1 1/2x1 1/2x7	3/4	5.50"
172760	623T	1 1/2x1 1/2x7	1	6.00"
172753	617T	1 1/2x1 1/2x7	1 1/2	6.50"
172672	618T	1 1/2x1 1/2x7	2	7.00"
172763	624T	2x2x7	1	5.69"
172764	625T	2x2x7	1 1/2	6.12"
172754	619T	2x2x7	2	6.50"
172673	620T	2x2x7	3	7.00"

Pump Construction: Standard Buna/Carbon-Ceramic Seal, maximum 175 psi working pressure, motors are 1750 RPM ODP. Three Phase are 208-230/460 volts, Single Phase 115/230 volts.

Figure A.5 (*Continued*)

SERIES 60 STOCK PUMPS

ALL BRONZE CONSTRUCTION

SINGLE PHASE UNITS

PART #	MODEL	PUMP SIZE	MOTOR HP	IMPELLER DIA.
172704	B601S	1x1x5 1/4	1/4	4.38"
172705	B602S	1x1x5 1/4	1/3	4.84"
172706	B603S	1x1x5 1/4	1/2	5.25"
172709	B604S	1 1/4x1 1/4x5 1/4	1/4	4.38"
172710	B605S	1 1/4x1 1/4x5 1/4	1/3	4.84"
172711	B606S	1 1/4x1 1/4x5 1/4	1/2	5.25"
172714	B607S	1 1/2x1 1/2x5 1/4	1/3	4.38"
172715	B608S	1 1/2x1 1/2x5 1/4	1/2	4.94"
172716	B609S	1 1/2x1 1/2x5 1/4	3/4	5.25"
172719	B610S	2x2x5 1/4	1/2	4.12"
172720	B611S	2x2x5 1/4	3/4	4.75"
172721	B612S	2x2x5 1/4	1	5.25"

THREE PHASE UNITS

PART #	MODEL	PUMP SIZE	MOTOR HP	IMPELLER DIA.
172728	B601T	1x1x5 1/4	1/4	4.38"
172729	B602T	1x1x5 1/4	1/3	4.84"
172730	B603T	1x1x5 1/4	1/2	5.25"
172734	B604T	1 1/4x1 1/4x5 1/4	1/4	4.38"
172735	B605T	1 1/4x1 1/4x5 1/4	1/3	4.84"
172736	B606T	1 1/4x1 1/4x5 1/4	1/2	5.25"
172740	B607T	1 1/2x1 1/2x5 1/4	1/3	4.38"
172741	B608T	1 1/2x1 1/2x5 1/4	1/2	4.94"
172742	B609T	1 1/2x1 1/2x5 1/4	3/4	5.25"
172746	B610T	2x2x5 1/4	1/2	4.00"
172747	B611T	2x2x5 1/4	3/4	4.75"
172748	B612T	2x2x5 1/4	1	5.25"

Pump Construction: Standard Buna/Carbon-Ceramic Seal,
maximum 175 psi working pressure,
motors are 1750 RPM ODP.
Three Phase are 208-230/460 volts,
Single Phase 115/230 volts.

Figure A.5 (*Continued*)

SERIES 60 BUILT-TO-ORDER PUMP PERFORMANCE CURVES

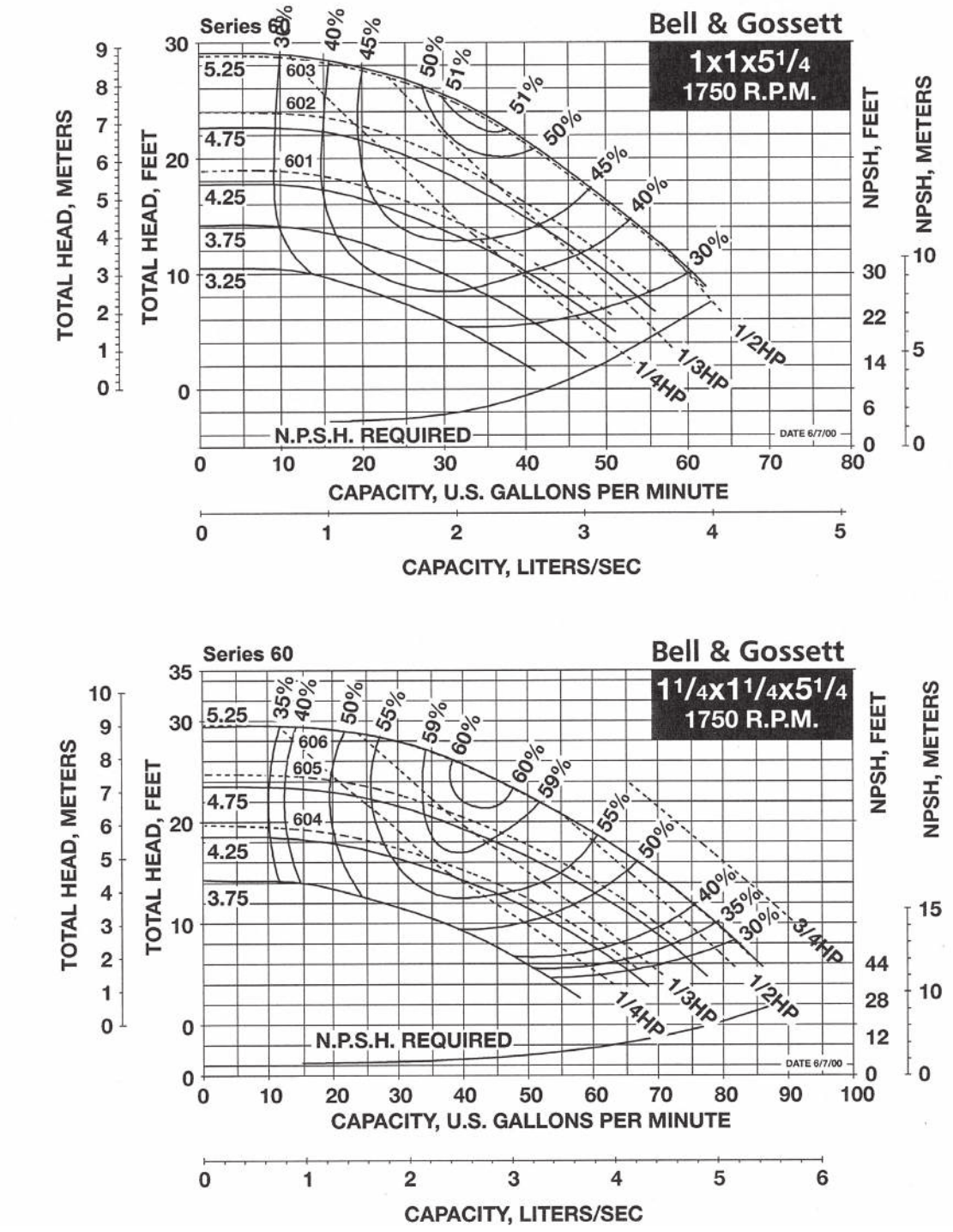

Figure A.5 (*Continued*)

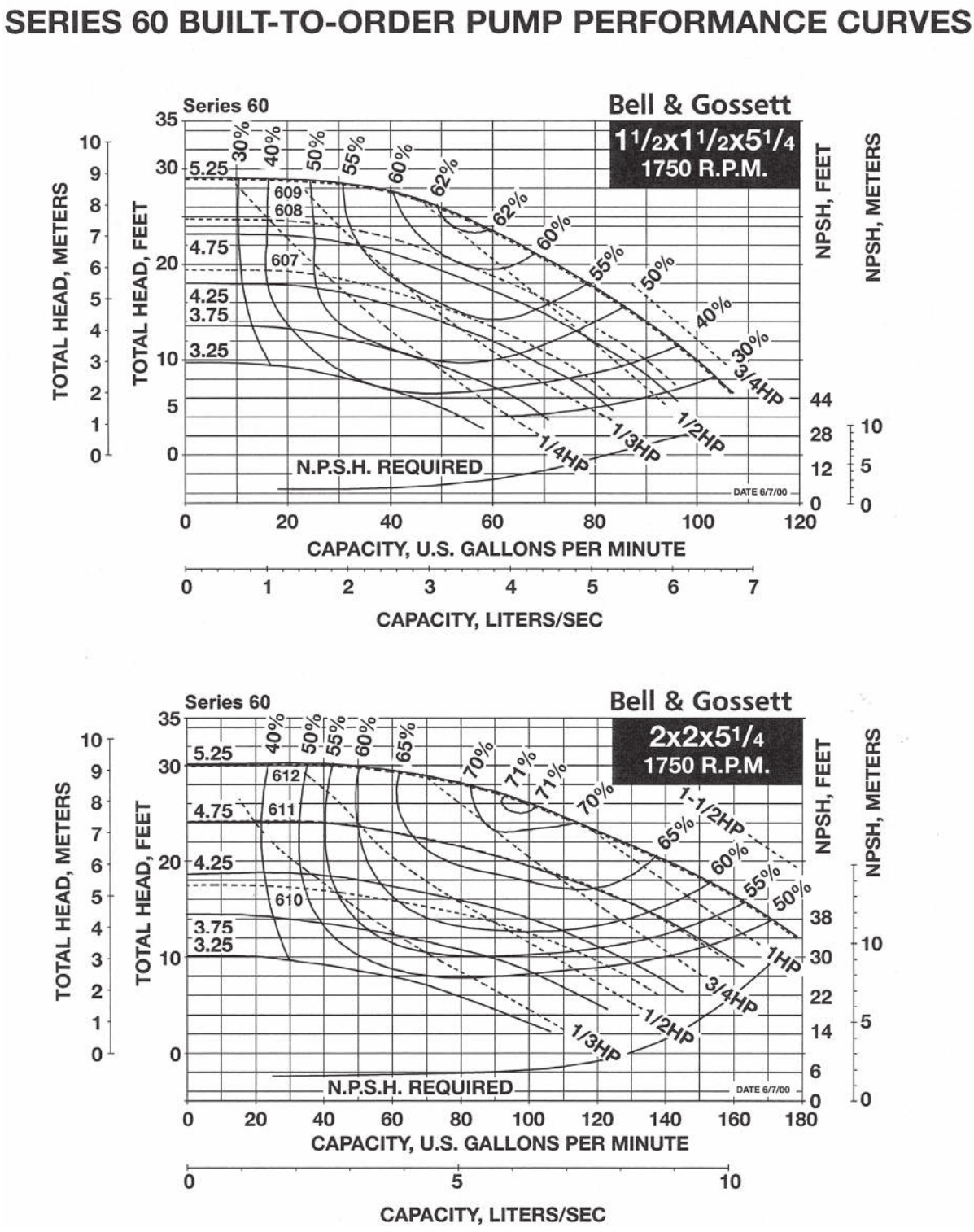

Figure A.5 (*Continued*)

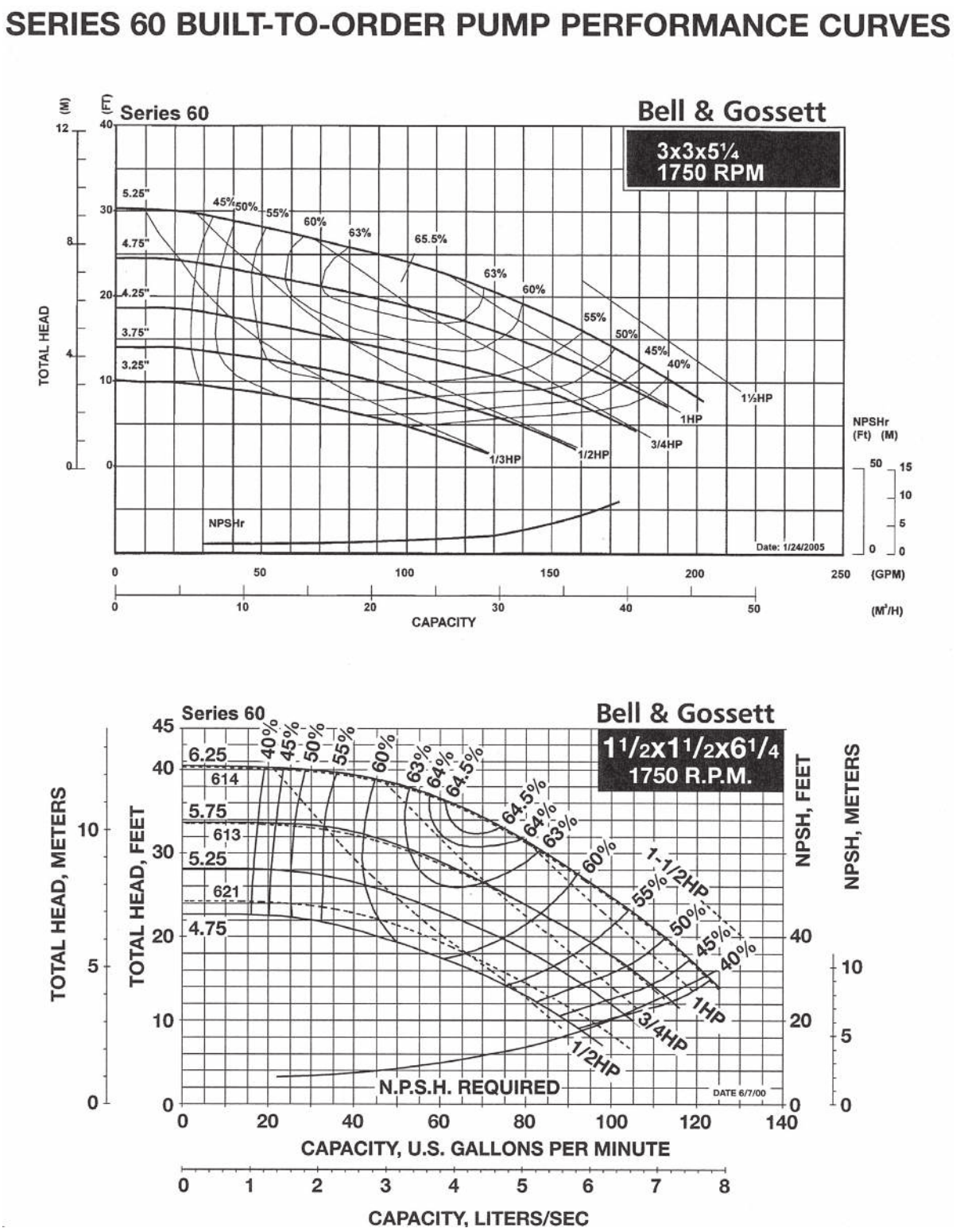

Figure A.5 (*Continued*)

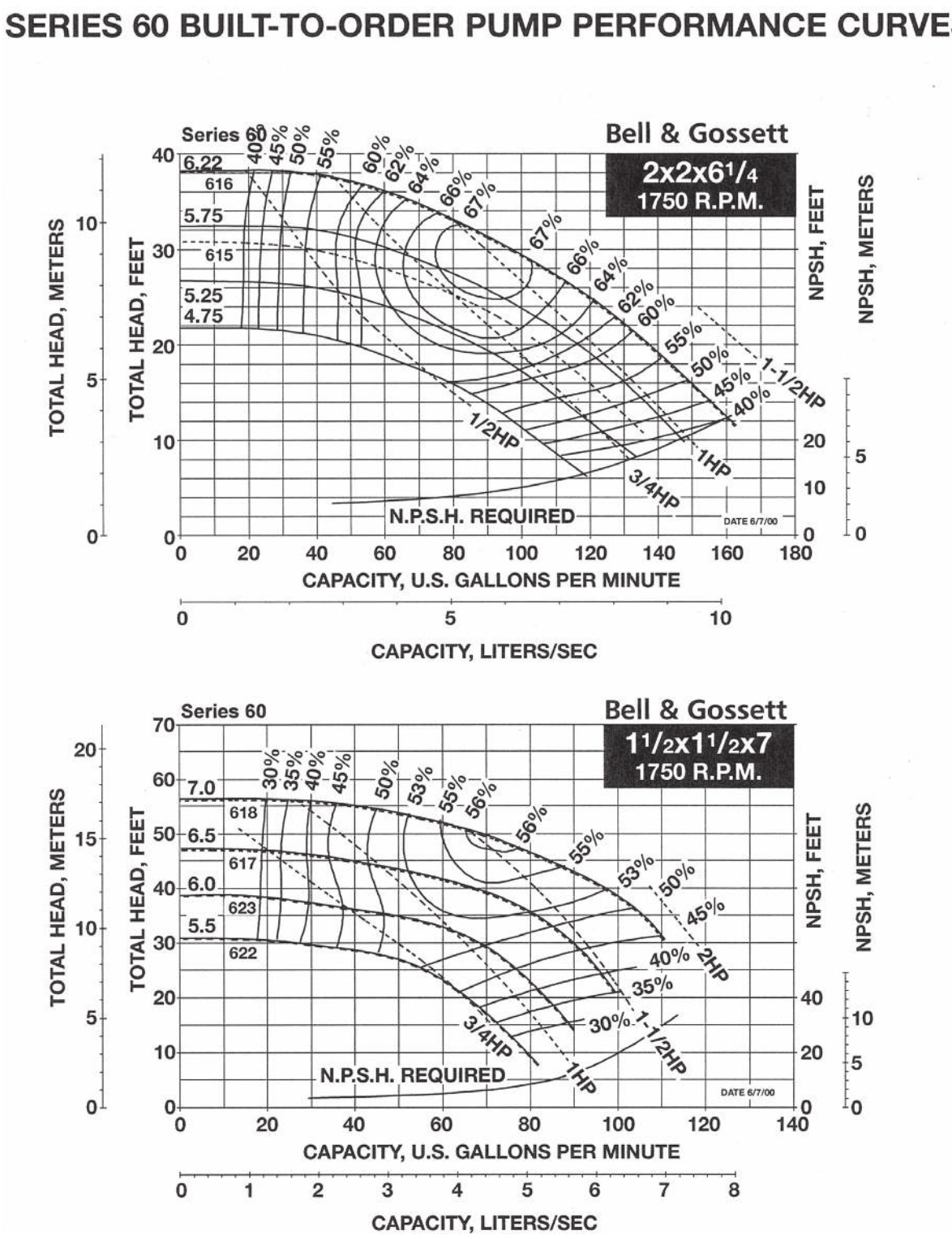

Figure A.5 (*Continued*)

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SERIES 60 BUILT-TO-ORDER PUMP PERFORMANCE CURVES

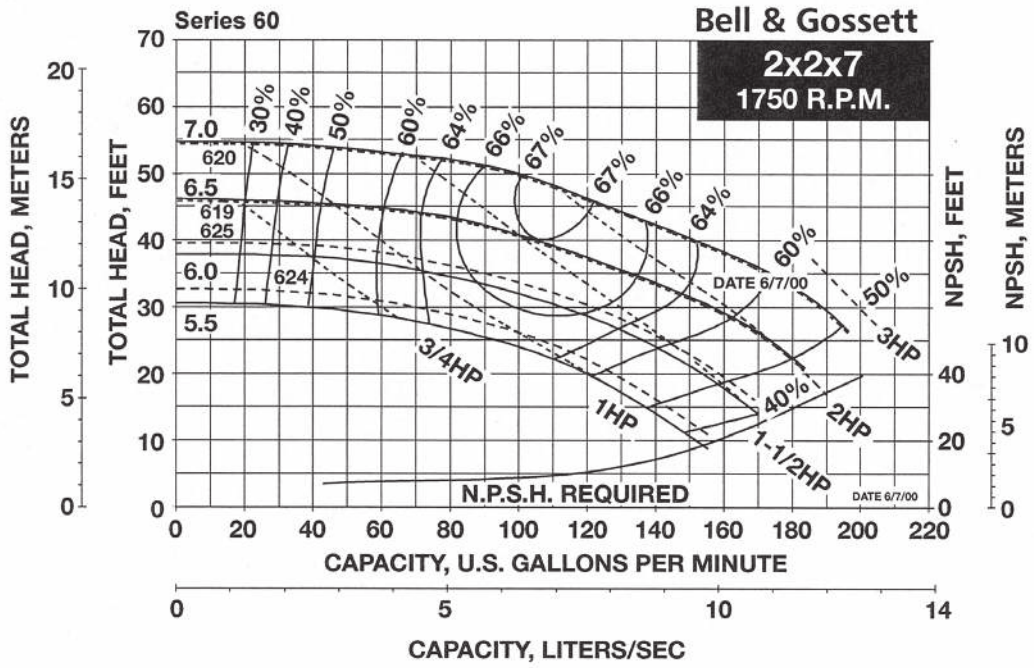

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Figure A.5 (*Continued*)