EQUIVALENTS & CONVERSION FACTORS

A MULTIPLY	B BY	C TO OBTAIN
Atmospheres	14.697	Pounds per sq. in.
Atmospheres	1.033	Kilograms per sq. cm
Atmospheres	29.92	Inches of mercury
Atmospheres	760	Millimeters of mercury
Atmospheres	407	Inches of water
Atmospheres	33.90	Feet of water
Barrels (petroleum)	42	Gallons
Barrels per day	0.0292	Gallons per minute
Bars-G	14.5	Pounds per sq. in
Centimeters	0.3937	Inches
Centimeters	0.03281	Feet
Centimeters	0.01	Meters
Centimeters	0.01094	Yards
Cubic Centimeters	0.06102	Cubic inches
Cubic feet	7.48055	Gallons
Cubic feet	0.17812	Barrels
Cubic feet	0.02832	Meters
Cubic feet per second	448.833	Gallons per minute
Cubic inches	16.39	Cubic centimeters
Cubic inches	0.004329	Gallons
Cubic meters	264.17	Gallons
Cubic meters per hour	4.4	Gallons per minute
Feet	0.3048	Meters
Feet	0.3333	Yards
Feet	30.48	Centimeters
Feet of water	0.882	Inches of mercury
Feet of water	0.433	Pounds per sq. in.
Gallons (U.S.)	3785	Cubic centimeters
Gallons (U.S.)	0.13368	Cubic feet
Gallons (U.S.)	231	Cubic inches
Gallons (Imperial)	277.4	Cubic inches
Gallons (U.S.)	0.833	Gallons (Imperial)
Gallons (U.S.)	3.785	Liters
Gallons of water	8.328	Pounds (at 70ºF)
Gallons of liquid per minute	500 x Sp. GR	Pounds per hr. liquid (at 70ºF)
Gallons per minute	0.002228	Cubic feet per second
Horsepower (boiler)	34.5	Pounds water per hr. evaporation
Horsepower (boiler)	33479	Btu per hour
Inches	2.54	Centimeters
Inches	0.0833	Feet
Inches	0.0254	Meters
Inches	0.02778	Yards
Inches of mercury	1.133	Feet of water

A MULTIPLY	B BY	C TO OBTAIN
Inches of mercury	0.4912	Pounds per sq. in.
Inches of mercury	0.0345	Kilograms per sq. cm.
Inches of water	0.03613	Pounds per sq. in.
Inches of water	0.07355	Inches of mercury
Kilograms	2.205	Pounds
Kilograms	0.001102	Short tons (2000 lbs.)
Kilograms per minute	132.3	Pounds per hour
Kilograms per sq. cm.	14.22	Pounds per sq. in.
Kilograms per sq. cm.	0.9678	Atmospheres
Kilograms per sq. cm.	28.96	Inches of mercury
Kilopascals	.145	Pounds per sq. in.
Liters	1000	Cubic centimeters
Liters	0.2642	Gallons (U.S.)
Liters per hour	0.0044	Gallons per minute (U.S.)
Meters	3.281	Feet
Meters	1.0936	Yards
Meters	100	Centimeters
Meters	39.37	Inches
Megapascals	.000145	Pounds per sq. in.
Pounds	0.0005	Short tons (2000 lbs.)
Pounds	0.4536	Kilograms
Pounds	0.000454	Metric tons
Pounds	16	Ounces
Pounds per hour	6.32/M.W.	Cubic feet per minute
Pounds per hour liquid	0.002/Sp. Gr.	Gallons per minute liquid (at 70ºF)
Pounds per sq. in.	27.684	Inches of water
Pounds per sq. in.	2.307	Feet of water
Pounds per sq. in.	2.036	Inches of mercury
Pounds per sq. in.	0.0703	Kilograms per sq. cm.
Pounds per sq. in.	51.71	Millimeters of mercury
Pounds per sq. in.	0.7037	Meters of water
Specific Gravity (of gas or vapors)	28.97	Molecular wt. (of gas or vapors)
Square centimeters	0.1550	Square inches
Square inches	6.452	Square centimeters
Tons (short ton. 2000 lbs.)	907.2	Kilograms
Tons (short ton. 2000 lbs.)	1.102	Metric tons
Tons (metric) per day	91.8	Pounds per hour
Water (cubic feet)	62.3	Pounds (at 70ºF)
Yards	0.9144	Meters
Yards	91.44	Centimeters

This table may be used in two ways:
(1) Multiply the unit under column A by the figure under column B; the result is the unit under column C.
(2) Divide the unit under column C by the figure under column B; the result is the unit under column A.

Note: ats is not responsible for content or accuracy of charts provided.

METRIC CONVERSIONS

QUANTITY	TO CONVERT FROM	TO	MULTIPLY BY
place angle	degree	rd	0.01745329
length	in	m	0.0254*
	ft	m	0.3048*
	yd	m	0.9144*
area	in^2	m^2	0.00064516*
	ft^2	m^2	0.0929034*
	yd^2	m^2	0.8361274
volume	in^3	m^3	0.00001638706
	ft^3	m^3	0.02831685
	U.S. gallon	m^3	0.00003785412
	Imperial gallon	m^3	0.004546090
	liter	m^3	0.001*
mass	lb (avoir.)	kg	0.4535924
	ton (metric)	kg	1000*
	ton (short 2000 lbm)	kg	907.1847
pressure, stress	kgf/m^2	Pa	9.80665*
	lbf/ft^2	Pa	0.4788026
	lbf/in^2 (psi)	kPa	6894.757
	$kips/in^2$	Pa	6894757
	bar	Pa	0.00001*
energy, work	Btu (IT) **	J	1055.056
	ft x lbf	J	1.355818
power	hp (550 ft x lbf/s)	W	745.6999
temperature	ºC	K	K = ºC + 273.15
	ºF	K	K = (ºF +459.67)1/1.8
	ºF	ºC	ºC = (ºF -32)1/1.8
	ºF	ºR	ºR = ºF + 459.67
temperature interval	ºC	K	1.0*
	ºF	K or ºC	0.5555555

* Relationships that are exact in terms of the base units are followed by a single asterisk.

** International Table

K = Absolute Temperature

QUANTITY	UNIT	SYMBOL	OTHER UNITS OR LIMITATIONS
temperature-thermo **	kelvin	K	degree Celsius (ºC)
temperature-other than thermodynamic	degree	ºC	kelvin (K)
lin. expansion coeff		K^{-1}	$ºC^{-1}$
quantity of heat	joule	J	
heat flow rate	watt	W	
thermal conductivity		W / (m x K)	W / (m x C)
thermal diffusivity	m^2 / s		
specific heat capacity		J / (kg x K)	J / (kg x C)

* Conversion factors between SI units and US customary are given in "ASME Orientation and Guide for Use of Metric Units" and "ASTM E-308."

** Perferred use for temperature interval is degrees Celsius (ºC), except for thermodynamic and cyogenic work where kelvins may be more suitable. For temperature interval 1K = 1C exactly.

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CONVENTIONAL FLOW ROOF DRAIN SIZING

HOW TO SELECT A ROOF DRAIN

To select the proper roof drain, the following information must be determined by the specifier.

*Type of roof construction
*Roof pitch
*Volume of expected rainfall
*Desired rate of drainage
*Roof load and safety overflow requirements
*Location of drains
*Size
*Vandal-proofing
*Local Code requirements

SECTION OF ROOF DRAIN BODY

Heavy rainfall region	Light rainfall region
use 16" diameter type for large or small roof areas	use 12" diameter type for small roof areas

STEPS DOR SELECTING PROPER ROOF DRAIN LEADER SIZES AND NUMBER REQUIRED FOR A GIVEN ROOF

1. Calculate the total roof area.
2. Determine the maximum hourly rainfall in inches. (The figure can be acquired from your local weather bureau and/or local code authority.)
3. Select leader size.
4. From Table 1, determine the number of square feet that can be drained by one roof leader at the local maximum rainfall rate.
5. Divide the total roof area by the area that one leader will handle. The above result is the number of roof drains required for the building. If the result is a fraction less, use the next higher number.

Example:

1. Total roof area - 500" by 270" equals 135,000sq. ft.
2. Determine rate of rainfall - for this example use 4".
3. After studying plan and physical arrangement, assume that 6" leaders are requires for this job.
4. From Table 1. - one 6" leader at 4" rate of rainfall will take care of 13,500 sq. ft. of roof area.
5. Number of roof leaders required is 10 (135,000 sq. ft. divided by 13,500 sq. ft.), thus 10 roof drains would be required.

NOTE: It can readily be seen that if 4" leaders were used, the number of roof drains required would increase to 30 drains. (29.348 rounded off to the next highest number.) If a smaller number of roof drains are required, then larger leaders would have to be chosen. Several small drains and leaders rather than one or two large drains will ensure even safer yet adequate roof drainage. Drains should be spaced for uniform drainage.

ROOF DRAIN VERTICAL LEADER REQUIREMENTS FOR HORIZONTAL ROOF AREAS AT VARIOUS RAINFALL RATES

LEADERS Pipe size Inches	Size Open Area Sq. In.	Hourly Rainfall In Inches									
		1	1 1/2	2	2 1/2	3	4	5	6	7	8
02	3.14	2 880	1 920	1 440	1 150	960	720	575	480	410	360
03	7.06	8 880	5 860	4 400	3 520	2 930	2 200	1 760	1 470	1 260	1 100
04	12.56	18 400	12 700	9 200	7 360	6 130	4 600	3 680	3 070	2 630	2 300
05	19.60	34 600	23 050	17 300	13 840	11 530	8 650	6 920	5 765	4 945	4 325
06	28.30	54 000	36 000	27 000	21 600	18 000	13 500	10 800	9 000	7 715	6 750
08	50.25	116 000	77 400	58 000	46 400	38 680	29 000	23 200	19 315	16 570	14 500

NOTE: Above table is for leader sizes. Select drains with adequate open free area in proportion to the leader size and consistent with code requirements.

TABLE 1

BASED ON NATIONAL PLUMBING CODE (Always consult your local code for these roof areas)

STEPS FOR CALCULATING DRAINAGE REQUIREMENTS FOR ABOVE EXAMPLE USING G.P.M.

1. Use the following formula to determine G.P.M.
   GPM = .0104 x P x A
   GPM = Gallons per minute
   R = Rainfall intensity - inches/hour
   A = Roof area - square feet
   .0104 = Conversion factor - G.P.M. /sq. ft. for one (1) inch/hr. rainfall
2. Example:
   A. 4" rainfall in./hr.
   B. 135,000 sq. ft. roof area
   C. GPM = .0104 x 4" x 135,000 sq. ft. = 5616 GPM (Use 5620)
3. Refer to table 2: a 4" leader will handle 192 G.P.M. 5616 divided by 192 equals 29.25 or (30) 4" vertical leaders required.
   A 6" leader will handle 566 G.P.M. 5616 divided by 566 equals 9.9 or (10) 6" leaders required.

Note: ats is not responsible for content or accuracy of charts provided.

ALLOWABLE FLOW FOR VERTICAL LEADERS AND HORIZONTAL STORM DRAINS

PIPE SIZE	VERTICAL LEADER	ALLOWABLE FLOW IN G.P.M. HORIZONTAL STORM DRIAN SLOPE PER FOOT		
		1/8"	1/4"	1/2"
02	30	12	17	24
03	90	36	51	72
04	192	78	111	157
05	348	142	201	284
06	566	231	327	462
08	1220	498	705	996
10	2200	902	1275	1804
12		1467	2076	2934
15		2666	3774	5332

TABLE 2

CFS DISCHARGE - SEWERS FLOWING FULL
(BASED ON KUTTERS FORMULA N = .013)

GRADE OF SEWER	4 INCH.		6 INCH.		8 INCH.		9 INCH.		10 INCH.		12 INCH.		15 INCH.		18 INCH.	
	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
.1	5.75	.5	7.99	1.57	10.04	3.5	10.99	5.0	11.94	6.5	13.73	10.8	16.24	20.0	18.59	33
.05	4.06	.355	5.64	1.11	7.09	2.45	7.76	3.52	8.43	4.6	9.70	7.6	11.48	14.0	13.13	23.2
.04	3.63	.317	5.05	.99	6.34	2.2	6.94	3.17	7.54	4.12	8.65	6.8	10.26	12.6	11.74	20.8
.03	3.15	.275	4.35	.85	5.49	1.92	6.01	2.75	6.53	3.58	7.51	5.9	8.89	10.9	10.17	18.2
.02	2.57	.21	3.56	.70	4.48	1.56	4.90	1.95	5.33	2.92	6.13	4.81	7.25	8.85	8.30	14.7
.01	1.82	.158	2.52	.495	3.17	1.1	3.47	1.58	3.77	2.06	4.33	3.4	5.13	6.3	5.87	10.04
.009	1.71	.149	2.39	.45	3.0	1.05	3.28	1.50	3.57	1.95	4.10	3.2	4.86	5.98	5.56	9.8
.008	1.61	.139	2.25	.44	2.83	1.0	3.10	1.42	3.37	1.83	3.87	3.05	4.59	5.62	5.25	9.3
.007	1.50	.13	2.10	.416	2.64	.92	2.89	1.32	3.14	1.71	3.61	2.84	4.28	5.30	4.90	8.67
.006	1.38	.12	1.95	.383	2.45	.85	2.69	1.3	2.92	1.58	3.35	2.64	3.97	4.87	4.55	8.0
.005			1.77	.35	2.22	.78	2.44	1.11	2.65	1.43	3.04	2.40	3.60	4.43	4.12	7.3
.004			1.59	.311	2.0	.70	2.19	1.0	2.38	1.30	2.74	2.15	3.24	4.0	3.70	6.54
.003					1.70	.60	1.86	.85	2.03	1.11	2.33	1.83	2.75	3.4	3.15	5.6

To convert C.F.S. to G.P.M. multiply by 448.831

$$Q = \frac{\text{SQ. FOOTAGE OF ROOF X RAINFALL X ABSORPTION FACTOR}}{43{,}200\ (\text{SQ.FT.IN ACRE})} = \text{C.F.S.}$$

GRADE OF SEWER	21 INCH.		24 INCH.		27 INCH.		30 INCH.		33 INCH.		36 INCH.		39 INCH.		42 INCH.	
	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
.1	20.80	50	22.91	72	24.87	101.8	26.84	134	28.69	170	30.46	216				
.05	14.69	35.5	16.19	50.7	17.58	72	18.97	93	20.27	120	21.54	152				
.04	13.14	31.5	14.47	45.5	15.71	64	16.96	83	18.13	108	19.26	135	20.50	175	21.2	250
.03	11.38	27.6	12.53	39.4	13.61	56	14.69	72	15.70	93.2	16.68	118	17.90	153	18.50	175
.02	9.29	22.5	10.23	32.0	11.11	45.5	11.99	59	12.82	76.3	13.62	96.8	14.50	120	15.0	145
.01	6.56	15.9	7.24	22.75	7.86	32.2	8.48	41.7	9.06	54	9.63	68.4	10.20	85	10.70	100
.009	6.22	15.0	6.85	21.5	7.44	30.2	8.03	39.5	8.59	51	9.12	65	9.70	80	10.0	95
.008	5.87	14.2	6.47	20.0	7.03	28.7	7.58	37	8.11	48.3	8.61	61	9.10	78	9.50	90
.007	5.47	13.5	6.04	19.0	6.56	26.9	7.07	35	7.56	45	8.04	56.6	8.60	71	8.90	83
.006	5.09	12.3	5.6	17.6	6.08	25	6.57	32.2	7.02	41.7	7.46	52.6	7.95	68	8.30	78
.005	4.62	11.15	5.08	16.0	5.52	22.6	5.96	29.2	6.37	37.9	6.77	48.2	7.20	61	7.50	71
.004	4.14	10.0	4.56	14.35	4.96	20.3	5.35	26.3	5.72	34	6.08	43	6.50	54	6.80	63
.003	3.53	8.5	3.89	12.3	4.0	17.25	4.56	22.4	4.87	29	5.18	36.7	5.60	47	5.85	55

To convert G.P.M. (Gal. Per Min.) to C.F.S (Cu. Ft. per sec.) multiply G.P.M. by 2.228 x 10(-3)

CONVERSION FACTORS					
WHERE 'N' EQUALS	0.011	0.012	0.013	0.014	0.015
MULTIPLY BY	1.20	1.09	1.00	0.92	0.84

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RAINFALL PER SQ. AREA (BASED ON 4"/HR)

SQ. FT.	G. P. H.	G. P. M.	CU. FT./H	CU. FT./M	CU. FT./S
1	2.49	0.042	0.33	0.0055	0.00009
2	4.98	0.083	0.67	0.0111	0.00018
3	7.48	0.124	1.00	0.0166	0.00027
4	9.97	0.166	1.34	0.0223	0.00037
5	12.46	0.207	1.67	0.0278	0.00046
6	14.96	0.249	2.00	0.0333	0.00055
7	17.45	0.290	2.34	0.0390	0.00065
8	19.94	0.332	2.67	0.0445	0.00074
9	22.44	0.374	3.00	0.0500	0.00083
10	24.93	0.415	3.34	0.0556	0.00092
20	49.80	0.830	6.67	0.1110	0.00185
30	74.80	1.246	10.00	0.1660	0.00277
40	99.70	1.661	13.34	0.2230	0.00372
50	124.50	2.070	16.67	0.2780	0.00463
60	149.40	2.490	20.00	0.3330	0.00555
70	174.50	2.900	23.34	0.3900	0.00650
80	199.40	3.320	26.67	0.4450	0.00741
90	224.40	3.740	30.00	0.5000	0.00833
100	249.30	4.150	33.34	0.5560	0.00926
200	498.00	8.300	66.67	1.1110	0.01852
300	748.00	12.466	100.00	1.6660	0.0277
400	997.00	16.616	133.34	2.2330	0.0372
500	1245.00	20.760	166.67	2.7830	0.0463
600	1494.00	24.980	200.00	3.3330	0.0555
700	1745.00	29.080	233.34	3.9000	0.0650
800	1994.00	33.230	266.67	4.4500	0.0741
900	2244.00	37.400	300.00	5.0000	0.0833
1000	2493.00	41.500	333.34	5.5600	0.0926
2000	4989.00	83.000	666.70	11.1160	0.1852
3000	7489.00	124.660	1000.00	16.6600	0.2776
4000	9979.00	166.160	1333.40	22.3300	0.3722
5000	12459.00	207.660	1666.70	27.8300	0.4638
6000	14949.00	249.830	2000.00	33.3300	0.555
7000	17459.00	290.830	2333.40	39.0000	0.650
8000	19949.00	332.330	2666.70	44.5000	0.741
9000	22449.00	374.000	3000.00	50.0000	0.833
10000	24939.00	415.000	3333.40	55.6600	0.926
20000	49899.00	830.000	6666.70	111.1600	1.852
30000	74899.00	1246.660	10000.00	166.6600	2.776
40000	99799.00	1661.660	13333.40	223.3300	3.722
50000	124599.00	2076.660	16666.67	278.3300	4.638
60000	149499.00	2498.330	20000.00	333.3300	5.555
70000	174599.00	2908.330	23333.40	390.0000	6.500
80000	199499.00	3323.330	26666.70	445.0000	7.416
90000	224499.00	3740.000	30000.00	500.0000	8.333
100000	249399.00	4150.000	33333.40	556.6600	9.266

FOR OTHER RAINFALL RATES

2" (52mm) multiply by 0.5
3" (76mm) multiply by 0.75
5" (127mm) multiply by 1.25
6" (152mm) multiply by 1.5
7" (178mm) multiply by 1.75
8" (203mm) multiply by 2.0

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RAINFALL PER SQ. METER (BASED ON 100MM/HR.)

SQ. M.	LITRE / H	LITRE / M	LITRE / S	M^3 / H	M^3 / M	M^3 / S
1	100	1.67	0.03	0.1	0.00167	0.000028
2	200	3.33	0.05	0.2	0.00333	0.000056
3	300	4.99	0.08	0.3	0.00499	0.000084
4	400	6.66	0.11	0.4	0.00666	0.000112
5	500	8.33	0.14	0.5	0.00833	0.000140
6	600	9.99	0.17	0.6	0.00999	0.000168
7	700	11.66	0.19	0.7	0.01166	0.000196
8	800	13.33	0.22	0.8	0.01333	0.000224
9	900	14.99	0.25	0.9	0.01499	0.000252
10	1000	16.66	0.28	1.0	0.01666	0.00028
20	2000	33.33	0.56	2.0	0.03333	0.00056
30	3000	49.99	0.83	3.0	0.04999	0.00084
40	4000	66.66	1.11	4.0	0.06666	0.00112
50	5000	83.33	1.39	5.0	0.08333	0.00140
60	6000	99.99	1.68	6.0	0.09999	0.00168
70	7000	116.66	1.95	7.0	0.11666	0.00196
80	8000	133.33	2.22	8.0	0.13333	0.00224
90	9000	149.99	2.50	9.0	0.14999	0.00252
100	10000	166.66	2.78	10.0	0.16666	0.0028
200	20000	333.33	5.56	20.0	0.33333	0.0056
300	30000	499.99	8.33	30.0	0.49999	0.0084
400	40000	666.66	11.11	40.0	0.66666	0.0112
500	50000	833.33	13.89	50.0	0.83333	0.0140
600	60000	999.99	16.67	60.0	0.99999	0.0168
700	70000	1166.66	19.45	70.0	1.16666	0.0196
800	80000	1333.33	22.22	80.0	1.33333	0.0224
900	90000	1499.99	25.00	90.0	1.49999	0.0252
1000	100000	1666.66	27.78	100.0	1.66666	0.028
2000	200000	3333.32	55.56	200.0	3.33332	0.056
3000	300000	4999.98	83.33	300.0	4.99998	0.084
4000	400000	6666.64	111.11	400.0	6.66664	0.112
5000	500000	8333.30	138.89	500.0	8.33330	0.140
6000	600000	9999.96	166.67	600.0	9.99996	0.168
7000	700000	11666.62	194.45	700.0	11.66620	0.196
8000	800000	13333.28	222.22	800.0	13.33328	0.224
9000	900000	14999.94	250.00	900.0	14.99994	0.252
10000	1000000	16666.60	277.78	1000.0	16.66660	0.28
20000	2000000	33333.28	555.56	2000.0	33.33328	0.56
30000	3000000	49999.80	833.34	3000.0	49.99980	0.84
40000	4000000	66666.40	1111.12	4000.0	66.66640	1.12
50000	5000000	83333.00	1388.90	5000.0	83.33330	1.40
60000	6000000	99999.60	1666.68	6000.0	99.99960	1.68
70000	7000000	116666.20	1944.46	7000.0	116.66620	1.96
80000	8000000	133332.80	2222.24	8000.0	133.33280	2.24
90000	9000000	149999.40	2500.02	9000.0	149.99940	2.52
100000	10000000	166666.00	2777.80	10000.0	166.66660	2.80

Note: ats is not responsible for content or accuracy of charts provided.

RAINTROL
FLOW CONTROL DRAIN

The RAINTROL roof drian was developed to offer certain advantageous features. Drains, leaders, storm sewers, etc. can be economically sized by controlling the flow of water. This will reflect in significant cost savings, both in material and labor. In addition, by controlling the drain rate, existing facilities can be utilized without overloading. Thus, new construction can be undertaken and tied into the present strom drains.

To accomplish the above, the RAINTROL drain retains water on the roof. The water is allowed to build up to a predetermined height, while the excess is drained off at a known maximum rate. The amount of net build-up is a function of rainfall intensity, time, roof area, and drain flow rate. Also note that the flow rate is a function of the build-up or head of water, and not the height of the weir. As an example, water at a 2" depth will flow througheither the four inch high or six inch high weir at the same rate.

The area rating, flow rate, and drain down time are given for various locations, consistent with the rainfall data for the localities. The data has been established for over 39 localities. Use of this data and tables will allow the engineer to lay out an efficient roof drainage system which will result in cost savings. Local codes must be observed to avoid conflict and approval problems.

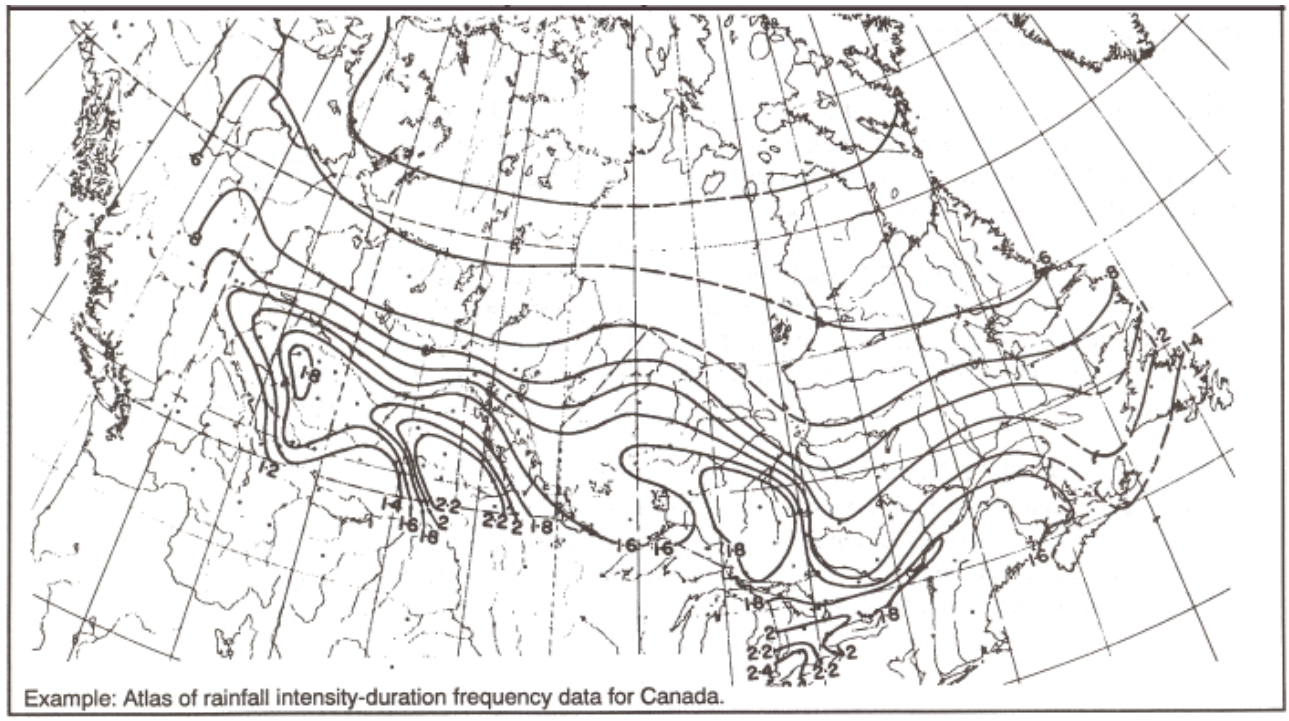
THE AREA RATING IS THE MAXIMUM AREA WHICH CAN BE HANDLED BY ONE WEIR OPENING. The corresponding flow rate and drain down time are also given. Data is presented for six conditions of roof slope. This provides data for four conditions for each locality.

DATA DERIVATION

The data presented in this brochure is the result or extensive computer processing. Rainfall information obtained from isopluvial maps was computer matched with the flow characteristics of the weir. The results were computer plotted and tabulated producing the final pages of tables in this brochure.

The Canadian climatological studies #8 contain the isopluvials which provide the informaiton for the Weiss Equations of Rainfall Intensity. This is more representative than other data avaliable for design purposes. It also covers all areas, not just point locations. The weir equations were developed from test data. When the two equations are solved simultaneously, the area ratings in the tables are produced. Because of the methods employed, extreme accuracy was realized. Fig. 1 is an example of an isopluvial map. Cities along the same isopluvial will have similar rainfall. This allows use of the data for locations which are not listed.

25 YEAR 1 HOUR RAINFALL (INCHES)



Example: Atlas of rainfall intensity-duration frequency data for Canada.

Note: ats is not responsible for content or accuracy of charts provided.

ROOF TYPES

The roof to be drained may vary from flat to a slope of 6" rise. Rise is measured vertically from the low point or valley to the high point or ridge. (Refer to Fig. 2 on the right.)

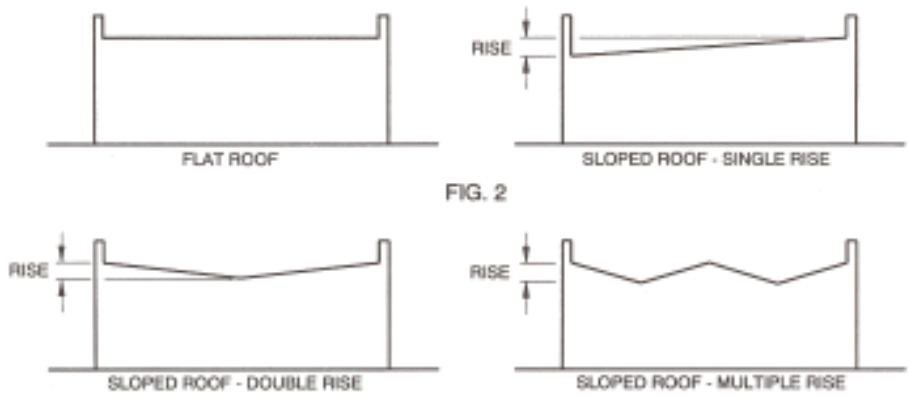
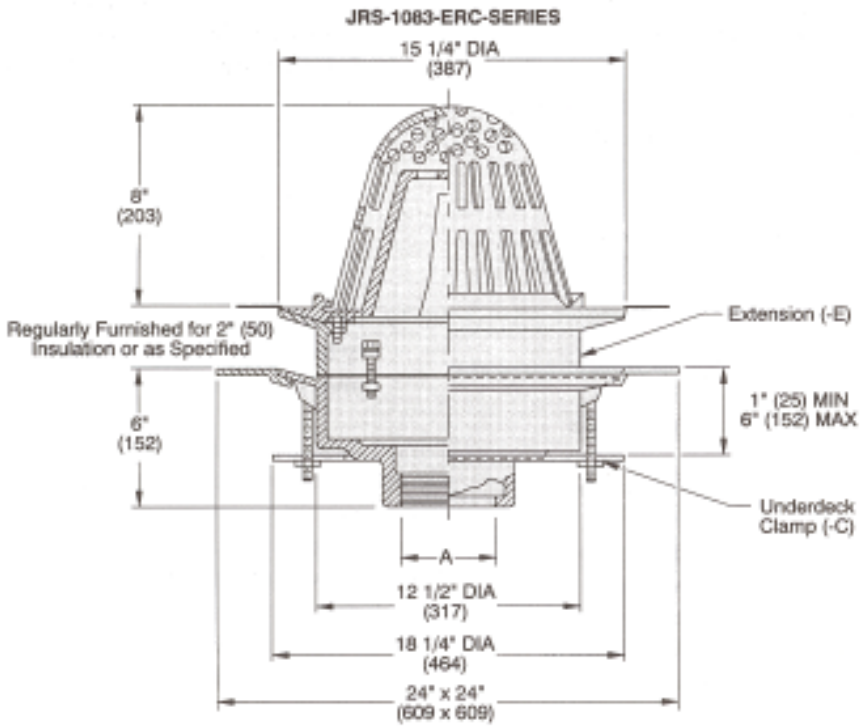


FIG. 2

RAINTROL® SPECIFICATIONS

The RAINTROL® Drain is offered with a six (6) inch weir which can be used on all roofs up to and including a sloped roof with a 6" rise. The flow rates for all RAINTROL® drains are shown on page 7.

Included in this brochure are tables of data for a number of localities. For locations not listed, use values for similar or nearby locations. For specific conditions which require more information, contact: Jay R. Smith, inc., 959 Alness St. North York, Ontario Canada M3J 2J1.



A = 2" (50) 3" (75) or 4" (100) Caulk, Thread or NO-HUB
NOTE: Dimensions in parenthesis are mm

SUGGESTED SPECIFICATION

Jay R. Smith, inc. Fig. # 1083-ERC (as shown above) with one weir opening RAINTROL® duco cast iron body with large sump and non-puncturing flashing clamping collar and gravel stop with integral cone with weir opening, extension with neoprene gasket, underdeck clamp, galvanized roof sump receiver and large dome. RAINTROL® Roof Drains are available as follows:

6" Head of water: Fig. 1083 for Bottom Outlet
and Fig. 1088 for Side Outlet

Note: ats is not responsible for content or accuracy of charts provided.

DRAIN SYSTEMS

The engineer should lay out the roof drain system consistent with the structural design strength of the roof. Normally for a flat roof with a 30 lbs. sq. ft. design load, the water depth or build up would be limited to 3". This will keep the load down to approximately 15 lbs./sq. ft. For sloped roofs the allowed water depth can be greater, but only to the point where stresses will be within the design limitations. This will be up to the discretion of the engineer.

The roof drainage can be based on a number of factors. The prime consideration could be economy, using minimum leaders and storm sewers. The allowable roof load or build up could limit the design. Or possibly, drain down time could be the limiting design criteria. In any case, knowing the maximum flow rates, which are controlled, the engineer can probably size leaders and storm sewers economically consistent with his/her selected design criteria.

DESIGN CONSIDERATIONS

When designing the roof drain system, the engineer must remember that the roof is being utilized as a temporary reservoir to retain some water. Flashing and waterproofing should be high enough to prevent any leakage. The engineer must also provide adequate strength for structural safety. In addition, the following considerations should be observed:

a. On roofs under 10,000 sq. ft. use a minimum of two (2) drains.
b. On roofs of 10,000 sq. ft. or greater, use a minimum of four (4) drains.
c. Limit roof area to 10,000 sq. ft. per weir opening.
d. Recommended maximum distance from roof edge to drain is 50 ft. (flat roofs).
e. Recommended maximum distance from end of valley to drain is 50 ft. (sloped roofs).
f. Recommended maximum distance between drains is 100 ft.
g. Provide adequate flashing at parapets, openings, walls, joints, etc.
h. Limit parapet walls or provide overflow scuppers. These should be located at the anticipated maximum water depth (build-up). If located in a higher position which could result in a greater flow rate, piping must be sized accordingly.
i. Consider wind effect in locating the drains, and the number of drains.
j. Possible roof deflection due to load. This could create low spots and adversly affect drainage and/or structural safety.

SPECIFYING AND SIZING (FLOW CONTROL)

Specifying can be done quickly and easily.

1. Determine the roof area to be drained, each area that is bound by expansion joints, ridges, and any enclosure is considered a separate roof area.
2. Divide the roof area by the area rating from the Table of Area Ratings (Table 1- Pages 12, 13, 14) to obtain the total number of weir openings.
3. Determine the number of roof drains. This is determined by the engineer and/or roof layout, using the above design considerations as a guide.
4. Divide the number of drains into the number of weir openings to obtain the number of weir openings per drain. It is not necessary that all drains have the same number of weir openings. As an example, a roof may require eight (8) weir openings, but only six (6)drains. In this case, four (4) drains could have one (1) weir opening and two (2) drains would have two (2) weir openings.

NOTE: Drains containing one weir opening are regularly furnished. Drains with two weir openings must be specified.

Table 1. From which the area rating is selected also lists the corresponding flow rate, water depth and drain down time. With this data the engineer can select the proper leader and storm sewer to accomodate the flow. Scupper or overflow protection must be set at the depth corresponding to the flow rate (Table 1 - Pages 12, 13, 14). This would limit the potential build-up, flow rate, and roof loading. If the scuppers are set at a higher level, the potential build-up would be greater. The weir height is the maximum potential build-up. Leaders and storm sewers would have to be sized for the higher flow rates which correspond to the greater buid-up. Also, a greater load might be placed on the roof. Refer to Table 3 on Page 11 for allowable rates. Select leaders and storm sewers, which will accommodate the maximum potential flow. Local codes may be the determining criteria and deviation must be approved. Examples showing the sizing method are on pages 10 and 11.

SPECIFYING AND SIZING (STANDARD FLOW)

DESIGN CONSIDERATIONS - same as a. thru j. as above.
SIZING TABLES - as per Table 1 on Page 3, and Tables on Pages 4, 5, and 6.

NOTE: Where vertical walls project above the roof, calculate as per the following:
- One wall, add 50% to roof area total.
- Two opposite walls, add 50%.

- water weighs 62. 4 lbs per cubic foot.
- to convert GPM to CFS, multiply GPM by 2.228×10^{-3}

Note: ats is not responsible for content or accuracy of charts provided.

TABLES

Table 1. On pages 12 through 14 is the area rating table for one weir and contains the principal data of this brochure. The localities are listed by provinces from East to West with their cities in alphabetical order. The data is divided according to the type of roof: Example: Flat, 2", 3", 4", 5" or 6" rise. The top figure is the area rating. Each block shows three (3) values. The left one is maximum flow rate for the particular area, the center one, the maximum depth and the right one is the drain down time based on draining from the maximum depth to a depth of one half inch, which is the practical minimum.

For values not shown in Table 1, straight line interpolation will give acceptable figures. Using this table will provide practical solutions. For necessary data not listed, the factory should be contacted. All data listed is based on a fifty-year (50) return period.

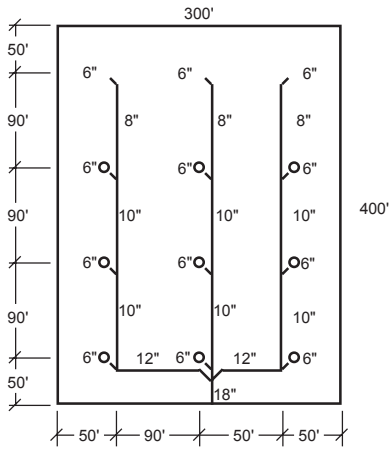
Table 2. Lists flow rated for various heads in 1 inch increments.

Table 3. Lists the allowable flow rates for various pipe sizes. Rates are given for vertical leaders and horizontal storm drains installed at four (4) different slopes. These values are consistent with the National Plumbing Code, and values obtained using Manning's formula.

EXAMPLES The following examples illustrate the advantages that can be achieved with RAINTROL roof drains.

FLAT LEVEL ROOF - TORONTO

Example 1
CONVENTIONAL METHOD:



Sizing is base on National Building Code of Canada, Plumbing Services Section. This example is based on 4" per hour rainfall.

1- Roof area: 300 x 400 = 120,000 ft. ^{2}

2- Area rating: 10, 000 ft. ^{2}/drain

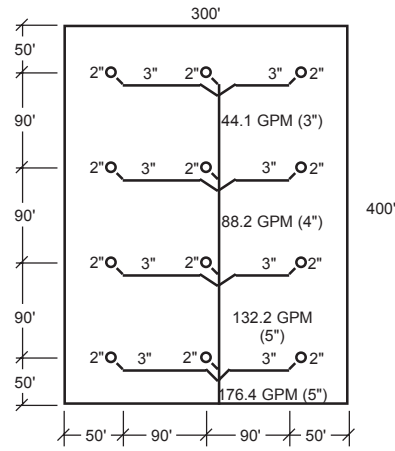
3- Flow rate: 416 GPM /drain

4- Total flow from roof: (12 x 416) = 4,992 GPM

Pipe requirements:
6" (152mm) dia. pipe- 240'
8" (203mm) dia. pipe - 300'
10" (254mm) dia. pipe - 600'
12" (305mm) dia. pipe - 210'
18" (457mm) dia. pipe - 50'

Drain requirements:
(12) 6" (152mm) dia.
Fig. JRS-1010
Roof Drains

Example 2
RAINTROL METHOD:



1- Roof area: 300 x 400 = 120,000 ft.^{2}

2- Area rating: 10,000 ft.^{2} / weir opening

3- Build-up: 3.2" - Drain down time: 42 hrs. (From table 1- column 10,000 sq. ft.)

4- Weir openings: 120,000 / 10,000 = 12

5- Number of drains: 12 drains with one weir opening each

6- Flow rate: 17.0 GPM / per weir opening at 3.2" depth

7- Total flow from roof: (12 x 17.0) = 204 GPM

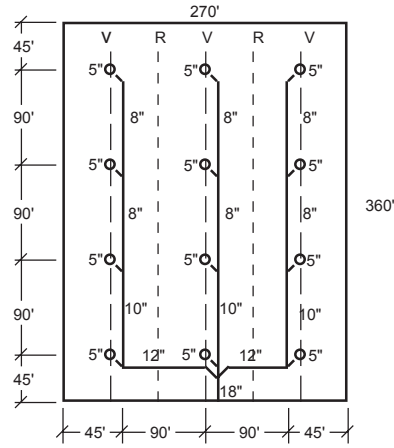
Pipe requirements:
2" (52mm) dia. pipe - 240'
3" (76mm) dia. pipe - 900'
4" (102mm) dia. pipe - 100'
5" (127mm) dia. pipe - 150'

Drain requirements:
(12) 2" (52mm) dia.
Fig. JRS-1083
Roof Drains

Note: ats is not responsible for content or accuracy of charts provided

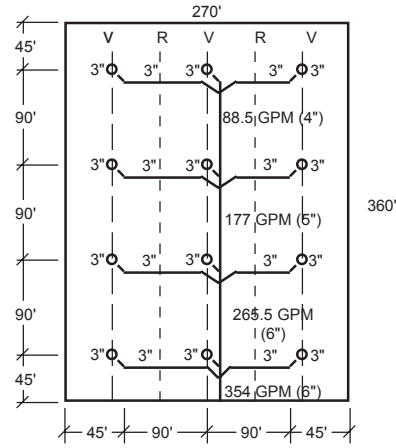
SLOPED ROOF - 6" (152MM) RISE IN QUEBEC CITY

Example 3
CONVENTIONAL METHOD:



V = Valley
R = Ridge

Example 4
RAINTROL METHOD:
(storm sewers 1/4" per ft. pitch)



Sizing is based on National Building Code of Canada, Plumbing Services Section. This example is based on 4" (102mm) per hour rainfall.

1- Roof area: 270 x 360 = 97,200 ft.^{2}

2- Area Rating: 8,100 ft.^{2} / drain

3- Flow rate: 337 GPM / drain

4- Total flow from roof: (12 x 337) = 4,044 GPM

Pipe requirements:
5" (125mm) dia. pipe - 240'
8" (203mm) dia. pipe - 540'
10" (254mm) dia. pipe - 270'
12" (305mm) dia. pipe - 180'
18" (457mm) dia. pipe - 45'

Drain requirements:
(12) 5" (125mm) dia.
Fig. JRS-1010
Roof Drains

1- Roof area: 270 x 360 = 97,200 ft.^{2}

2- Area rating: 10,000 ft.^{2} / weir opening

3- Build-up: 5.3" - Drain down time: 17.5 hrs. (From table 1 - column 10,000 sq. ft.)

4- Weir openings: 97,200 / 10,000 = 9.72 or 10
5- Number of drains: 12 drains with one weir opening each

6- Flow rate: 29.5 GPM / per weir opening at 5.3" depth

7- Total flow from roof: (12 x 29.5) = 354 GPM

Pipe requirements:
3" (76mm) dia. pipe - 960'
4" (102mm) dia. pipe - 90'
5" (125mm) dia. pipe - 90'
6" (152mm) dia. pipe - 135'

Drain requirements:
(12) 3" (76mm) dia.
Fig. JRS-1083
Roof Drains

TABLE 2

FLOW RATE VS. BUILD-UP ONE WEIR						
Depth - inches	1	2	3	4	5	6
Flow - GPM	5.0	10.5	15.7	21.5	27.5	34.5

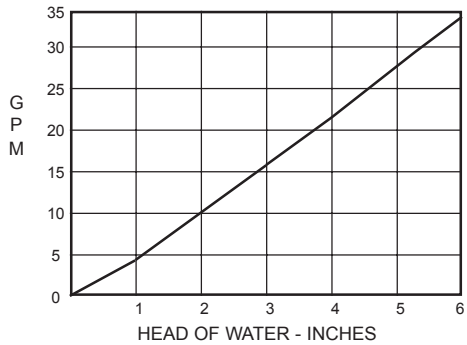


TABLE 3

ALLOWABLE FLOW FOR VERTICAL LEADERS AND HORIZONTAL STORM DRAINS

PIPE SIZE	ALLOWABLE FLOW IN GPM				
	VERTICAL LEADER	HORIZONTAL STORM DRAIN SLOPE PER FOOT			
		1/16"	1/8"	1/4"	1/2"
02	30	-	12	17	24
03	90	25	36	51	72
04	192	55	78	111	157
05	348	100	142	201	284
06	-	163	231	327	462
08	-	352	498	705	996
10	-	638	902	1275	1804
12	-	1035	1467	2076	2934
15	-	1880	2666	3774	5332
18	-	3050	4210	6000	-

Note: ats is not responsible for content or accuracyof charts provided

AREA RATING TABLE 1

LOCATION	Roof Slope (in.)	2,500 SQ. FT.			5,000 SQ. FT.			7,500 SQ. FT.			10,000 SQ. FT.		
		Flow Rate GPM	Water Depth (in.)	Drain Down Time	FlowRate GPM	Water Depth (in.)	Drain Down Time	Flow Rate GPM	Water Depth (in.)	Drain Down Time	Flow Rate GPM	Water Depth (in.)	Drain Down Time
GANDER NEWFOUND-LAND	0	11.0	2.1	8.0	13.0	2.5	18.0	14.2	2.7	29.0	15.3	2.9	40.0
	2	14.7	2.8	6.5	17.0	3.2	13.5	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.0	3.2	5.0	19.25	3.6	11.0	20.3	3.8	18.5	21.5	4.0	25.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	16.0	24.3	4.5	22.0
	5	21.5	4.0	4.0	23.7	4.4	9.0	25.0	4.6	14.0	26.0	4.8	19.5
	6	23.2	4.3	3.5	25.5	4.7	8.0	27.5	5.0	12.5	28.7	5.2	17.0
ST-ANDREWS NEWFOUND-LAND	0	11.0	2.1	8.0	13.0	2.5	18.5	14.2	2.7	29.5	15.3	2.9	40.0
	2	14.7	2.8	6.0	17.0	3.2	13.5	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	18.5	21.5	4.0	25.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	15.5	23.7	4.4	22.0
	5	21	3.9	4.0	23.7	4.4	8.5	25.0	4.6	14.0	25.5	4.7	19.5
	6	23.2	4.3	3.5	25.5	4.7	7.5	27.5	5.0	12.5	28.7	5.2	17.0
ST-JOHN'S NEWFOUND-LAND	0	12.0	2.3	8.5	13.5	2.6	19.0	14.7	2.8	30.0	16.5	3.1	43.0
	2	14.7	2.8	6.0	17.5	3.3	14.0	18.75	3.5	22.5	20.3	3.8	31.0
	3	17.5	3.3	5.0	19.25	3.6	11.5	21.0	3.9	19.0	22.0	4.1	25.0
	4	19.8	3.7	4.5	22.0	4.1	10.0	23.2	4.3	16.0	24.3	4.5	23.0
	5	21.5	4.0	4.0	24.3	4.5	9.0	25.5	4.7	14.0	26.75	4.9	20.0
	6	23.7	4.4	3.5	26.0	4.8	8.0	28.0	5.1	13.0	30.2	5.4	18.0
CHARLOTTE-TOWN P.E.I	0	11.5	2.2	8.5	13.0	2.5	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	15.3	2.9	6.5	17.0	3.2	14.0	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.5	3.3	5.0	19.25	3.6	11.5	20.3	3.8	18.0	21.5	4.0	25.0
	4	19.8	3.7	4.5	21.8	4.05	10.0	23.2	4.3	16.0	23.7	4.4	22.0
	5	22.0	4.1	4.0	24.3	4.5	9.0	25.5	4.7	14.0	26.0	4.8	20.0
	6	24.3	4.5	3.7	26.0	4.8	8.0	28.0	5.1	13.0	28.7	5.2	18.0
HALIFAX NOVA SCOTIA	0	15.3	2.9	10.0	18.75	3.5	22.5	21.0	3.9	3.5	22.5	4.2	48.0
	2	18.75	3.5	7.5	22.0	4.1	16.0	24.3	4.5	26.5	26.0	4.8	36.0
	3	20.3	3.8	6.0	24.3	4.5	14.0	26.0	4.8	22.0	28.0	5.1	31.0
	4	23.2	4.3	5.5	26.75	4.9	12.0	29.5	5.3	19.0	30.9	5.5	26.5
	5	25.5	4.7	5.0	29.5	5.3	10.5	32.5	5.7	17.0	34.8	5.0	24.0
	6	27.5	5.0	4.0	31.8	5.6	9.5	34.8	6.0	15.0	-	-	-
SYDNEY NOVA SCOTIA	0	11.5	2.2	8.5	13.0	2.5	19.0	14.2	2.7	30.0	15.7	3.0	41.0
	2	14.7	2.8	6.5	17.0	3.2	14.0	18.75	3.5	22.0	19.8	3.7	31.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	19.0	21.5	4.0	24.5
	4	19.25	3.6	4.5	21.75	4.05	10.0	23.2	4.3	15.5	24.3	4.5	22.5
	5	21.5	4.0	4.0	23.7	4.4	8.5	25.0	4.6	13.5	26.75	4.9	20.0
	6	23.7	4.4	3.5	25.5	4.7	8.0	27.75	5.05	12.5	29.5	5.3	18.0
YARMOUTH NOVA SCOTIA	0	15.3	2.9	10.0	18.75	3.5	22.5	21.0	3.9	35.0	22.5	4.2	48.0
	2	18.75	3.5	7.5	22.0	4.1	16.0	24.3	4.5	26.5	26.0	4.8	36.0
	3	20.3	3.8	6.0	24.3	4.5	14.0	26.0	4.8	22.0	28.0	5.1	31.0
	4	23.2	4.3	5.5	26.75	4.9	12.0	29.5	5.3	19.0	30.9	5.5	26.5
	5	25.5	4.7	5.0	29.5	5.3	10.5	32.5	5.7	17.0	34.8	6.0	24.0
	6	27.5	5.0	4.0	31.8	5.6	9.5	34.8	6.0	15.0	-	-	-
CAMBELLTOWN NEW BRUNSWICK	0	11.0	2.1	8.0	13.0	2.5	18.5	14.2	2.7	29.5	15.3	2.9	40.0
	2	14.7	2.8	6.0	17.0	3.2	13.5	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	18.5	21.5	4.0	25.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	15.5	23.7	4.4	22.0
	5	21.0	3.9	4.0	23.7	4.4	8.5	25.0	4.6	14.0	25.5	4.7	19.5
	6	23.2	4.3	3.5	25.5	4.7	7.5	27.5	5.0	12.5	28.7	5.2	17.0
CHATAM NEW BRUNSWICK	0	9.0	1.7	7.5	12.0	2.3	17.0	13.2	2.55	28.0	14.7	2.8	40.0
	2	12.5	2.4	5.0	14.7	2.8	12.5	16.5	3.1	21.0	18.75	3.5	29.0
	3	14.2	2.7	4.2	17.0	3.2	10.5	19.0	3.55	16.5	19.8	3.7	24.0
	4	15.7	3.0	3.5	18.75	3.5	8.5	21.0	3.9	14.0	22.0	4.1	20.5
	5	17.0	3.2	3.0	20.3	3.8	7.5	23.2	4.3	12.0	24.3	4.5	18.0
	6	18.0	3.4	2.75	22.5	4.2	6.75	24.3	4.5	11.5	25.5	4.7	16.0
MONCTON NEW BRUNSWICK	0	12.0	2.3	9.0	13.6	2.6	18.0	14.7	2.8	29.0	15.7	3.0	41.0
	2	16.5	3.1	6.5	18.0	3.4	14.0	19.0	3.55	22.0	19.8	3.7	31.0
	3	18.75	3.5	5.5	19.8	3.7	12.0	21.5	4.0	19.0	22.5	4.2	25.5
	4	21.5	4.0	5.0	22.75	4.25	10.5	24.0	4.45	16.0	24.5	4.55	22.0
	5	23.7	4.4	4.5	25.5	4.7	9.0	26.0	4.8	15.0	27.5	5.0	20.0
	6	25.5	4.7	4.0	28.0	5.1	8.5	29.5	5.3	13.5	30.9	5.5	18.0
ST-JOHN NEW BRUNSWICK	0	12.5	2.4	9.0	15.3	2.9	20.0	17.5	3.3	32.0	18.75	3.5	44.0
	2	15.7	3.0	6.5	18.75	3.5	14.5	21.0	3.9	24.0	22.5	4.2	32.5
	3	17.5	3.3	5.5	21.0	3.9	12.0	22.5	4.2	20.0	24.3	4.5	28.0
	4	19.8	3.7	4.5	22.5	4.2	11.0	25.0	4.6	17.0	26.75	4.9	24.0
	5	21.5	4.0	4.0	25.0	4.6	9.0	27.5	5.0	15.0	30.2	5.4	21.5
	6	23.2	4.3	3.5	27.5	5.0	8.0	30.2	5.4	14.0	31.8	5.6	19.5
CHICOUTIMI QUEBEC	0	6.0	1.2	7.0	10.0	1.9	15.0	11.0	2.1	24.0	11.75	2.25	33.0
	2	12.5	2.4	5.25	13.6	2.6	11.5	14.2	2.7	18.5	15.7	3.0	26.0
	3	14.2	2.7	4.5	15.7	3.0	10.0	17.5	3.3	16.0	18.0	3.4	22.0
	4	16.5	3.1	3.75	18.0	3.4	8.0	19.25	3.6	13.0	19.8	3.7	19.0
	5	18.0	3.4	3.25	19.8	3.7	7.0	21.5	4.0	12.0	22.0	4.1	16.0
	6	19.25	3.6	3.0	21.5	4.0	6.5	23.2	4.3	11.0	24.3	4.5	15.0
GASPE QUEBEC	0	9.0	1.7	7.5	12.0	2.3	17.0	13.25	2.55	28.0	14.7	2.8	40.0
	2	125	2.4	5.0	14.7	2.8	12.5	16.5	3.1	21.0	18.75	3.5	29.0
	3	14.2	2.7	4.2	17.0	3.2	10.5	19.0	3.55	16.5	19.8	3.7	24.0
	4	15.7	3.0	3.5	18.75	3.5	8.5	21.0	3.9	14.0	22.0	4.1	20.5
	5	17.0	3.2	3.0	20.3	3.8	7.5	23.2	4.3	12.0	24.3	4.5	18.0
	6	18.0	3.4	2.75	22.5	4.2	6.75	24.3	4.5	11.5	25.5	4.7	16.0

Note: ats is not responsible for content or accuracy of charts provided.

AREA RATING TABLE 1 (CONTINUED)

LOCATION	Roof Slope (in.)	2,500 SQ. FT. FlowRate GPM	2,500 SQ. FT. Water Depth (in.)	2,500 SQ. FT. Drain Down Time	5,000 SQ. FT. FlowRate GPM	5,000 SQ. FT. Water Depth (in.)	5,000 SQ. FT. Drain Down Time	7,500 SQ. FT. FlowRate GPM	7,500 SQ. FT. Water Depth (in.)	7,500 SQ. FT. Drain Down Time	10,000 SQ. FT. FlowRate GPM	10,000 SQ. FT. Water Depth (in.)	10,000 SQ. FT. Drain Down Time
MONTREAL QUEBEC	0	11.5	2.2	8.5	13.0	2.5	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	15.3	2.9	6.5	17.0	3.2	14.0	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.5	3.3	5.0	19.25	3.6	11.5	20.3	3.8	18.0	21.5	4.0	25.0
	4	19.8	3.7	4.5	21.8	4.05	10.0	23.2	4.3	16.0	23.7	4.4	22.0
	5	22.0	4.1	4.0	24.3	4.5	9.0	25.5	4.7	14.0	26.0	4.8	20.0
	6	24.3	4.5	3.7	26.0	4.8	8.0	28.0	5.1	13.0	28.7	5.2	18.0
QUEBEC CITY QUEBEC	0	11.5	2.2	8.5	13.0	2.5	18.0	14.2	2.7	29.5	15.3	2.9	41.0
	2	15.3	2.9	6.5	17.5	3.3	14.0	18.75	3.5	22.0	19.25	3.6	31.0
	3	17.6	3.35	5.5	19.8	3.7	11.75	21.0	3.9	19.0	21.5	4.0	25.0
	4	20.3	3.8	4.5	22.0	4.1	10.0	23.2	4.3	16.0	24.3	4.5	22.5
	5	22.0	4.1	4.0	24.3	4.5	9.0	25.5	4.7	14.0	26.75	4.9	20.0
	6	24.3	4.5	3.75	26.0	4.8	8.0	28.0	5.1	13.0	29.5	5.3	17.5
RIMOUSKI QUEBEC	0	9.0	1.7	7.5	12.0	2.3	17.0	13.2	2.55	28.0	14.7	2.8	40.0
	2	12.5	2.4	5.0	14.7	2.8	12.5	16.5	3.1	21.0	18.75	3.5	29.0
	3	14.2	2.7	4.2	17.0	3.2	10.5	19.0	2.55	16.5	19.8	3.7	24.0
	4	15.7	3.0	3.5	18.75	3.5	8.5	21.0	3.9	14.0	22.0	4.1	20.5
	5	17.0	3.2	3.0	20.3	3.8	7.5	23.2	4.3	12.0	24.3	4.5	18.0
	6	18.0	3.4	2.75	22.5	4.2	6.75	24.3	4.5	11.5	25.5	4.7	16.0
ROUYN-NORANDA QUEBEC	0	11.5	2.2	8.5	13.0	2.5	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	15.3	2.9	6.5	17.0	3.2	14.0	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.5	3.3	5.0	19.25	3.6	11.5	20.3	3.8	18.0	21.5	4.0	25.0
	4	19.8	3.7	4.5	21.8	4.05	10.0	23.2	4.3	16.0	23.7	4.4	22.0
	5	22.0	4.1	4.0	24.3	4.5	9.0	25.5	4.7	14.0	26.0	4.8	20.0
	6	24.3	4.5	3.7	26.0	4.8	8.0	28.0	5.1	13.0	28.7	5.2	18.0
SHERBROOKE QUEBEC	0	11.0	2.1	9.0	13.0	2.5	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	14.7	2.8	6.5	17.0	3.2	14.0	18.0	3.4	22.0	18.75	3.5	29.5
	3	17.5	3.3	5.0	19.25	3.6	11.5	20.3	3.8	18.0	21.5	4.0	24.0
	4	19.8	3.7	4.5	21.5	4.0	10.0	23.2	4.3	15.0	23.7	4.4	22.0
	5	21.5	4.0	4.0	24.3	4.5	8.5	25.0	4.6	14.0	26.0	4.8	19.0
	6	23.7	4.4	3.5	26.0	4.8	8.0	27.5	5.0	12.0	28.7	5.2	17.0
TROIS-RIVIERES QUEBEC	0	11.0	2.1	9.0	13.0	2.5	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	14.7	2.8	6.5	17.0	3.2	14.0	18.0	3.4	22.0	18.75	3.5	29.5
	3	17.5	3.3	5.0	19.25	3.6	11.5	20.3	3.8	18.0	21.5	4.0	24.0
	4	19.8	3.7	4.5	21.5	4.0	10.0	23.2	4.3	15.0	23.7	4.4	22.0
	5	21.5	4.0	4.0	24.3	4.5	8.5	25.0	4.6	14.0	26.0	4.8	19.0
	6	23.7	4.4	3.5	26.0	4.8	8.0	27.5	5.0	12.0	28.7	5.2	17.0
GUELPH ONTARIO	0	12.5	2.4	10.5	13.6	2.6	19.0	14.7	2.8	30.0	15.7	3.0	41.0
	2	17.0	3.2	7.0	18.25	3.45	14.5	19.25	3.6	23.0	19.8	3.7	31.0
	3	19.25	3.6	5.5	21.0	3.9	12.0	21.5	4.0	19.5	22.5	4.2	27.0
	4	21.5	4.0	5.0	23.2	4.3	10.5	24.3	4.5	16.0	25.0	4.6	23.0
	5	24.3	4.5	4.5	25.0	4.6	9.5	26.75	4.9	14.5	27.5	5.0	20.5
	6	26.0	4.8	4.0	28.0	5.1	9.0	29.5	5.3	13.0	30.9	5.5	19.0
HAMILTON ONTARIO	0	12.0	2.3	9.0	14.2	2.7	18.5	15.3	2.9	30.0	17.0	3.2	42.0
	2	15.7	3.0	6.5	18.0	3.4	14.5	19.25	3.6	23.0	20.3	3.8	31.0
	3	18.0	3.4	5.5	20.3	3.8	12.0	21.5	4.0	19.5	22.5	4.2	26.0
	4	20.3	3.8	5.0	23.2	4.3	10.5	24.3	4.5	17.0	25.0	4.6	23.0
	5	22.5	4.2	4.5	25.0	4.6	10.0	26.0	4.8	14.5	27.5	5.0	20.5
	6	25.0	4.6	4.0	27.5	5.0	8.0	29.5	5.3	13.0	30.2	5.4	19.0
KINGSTON ONTARIO	0	11.0	2.1	8.0	13.0	2.5	17.5	14.2	2.7	29.0	15.3	2.9	40.0
	2	14.7	2.8	6.0	16.5	3.1	13.5	18.0	3.4	22.0	19.0	3.55	30.0
	3	17.0	3.2	5.0	18.75	3.5	11.5	19.8	3.7	18.5	21.5	4.0	24.5
	4	19.25	3.6	4.5	21.5	4.0	10.0	22.5	4.2	16.0	23.7	4.4	22.0
	5	21.5	4.0	4.0	23.7	4.4	9.0	25.0	4.6	14.0	26.0	4.8	20.0
	6	23.2	4.3	3.5	23.2	4.3	8.0	27.5	5.0	12.0	28.7	5.2	17.0
LONDON ONTARIO	0	11.0	2.1	8.0	13.0	2.5	19.5	14.7	2.8	29.5	15.7	3.0	41.0
	2	14.7	2.8	6.0	17.0	3.2	14.0	18.75	3.5	23.0	19.25	3.6	30.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	19.0	21.5	4.0	25.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	16.0	23.7	4.4	21.5
	5	21.5	4.0	4.0	23.7	4.4	9.0	25.0	4.6	14.0	26.0	4.8	19.5
	6	23.2	4.3	3.5	26.0	4.3	8.0	27.5	5.0	12.5	28.7	5.2	17.0
NORTH BAY ONTARIO	0	9.0	1.7	7.0	11.5	2.2	17.0	13.0	2.5	28.0	14.7	2.8	40.0
	2	12.0	2.3	5.0	14.7	2.8	12.0	17.0	3.2	21.0	18.75	3.5	29.0
	3	13.2	2.55	4.0	16.5	3.1	10.0	18.75	3.5	16.0	19.8	3.7	24.0
	4	14.7	2.8	3.5	18.75	3.5	8.0	20.3	3.8	14.0	22.0	4.1	20.5
	5	15.7	3.0	2.75	19.8	3.7	7.0	22.0	4.1	12.0	24.0	4.45	17.5
	6	17.0	3.2	2.5	21.5	4.0	6.5	23.7	4.4	11.0	25.5	4.7	16.0
OTTAWA ONTARIO	0	11.5	2.2	8.0	12.5	2.4	18.0	13.6	2.6	29.0	14.7	2.8	39.0
	2	14.7	2.8	6.5	17.0	3.2	14.0	18.0	3.4	22.0	18.75	3.5	29.0
	3	18.0	3.4	5.5	19.25	3.6	11.5	20.3	3.8	19.0	21.0	3.9	24.0
	4	19.8	3.7	4.5	21.5	4.0	10.0	23.2	4.3	16.0	23.7	4.4	21.5
	5	22.5	4.2	4.0	23.7	4.4	9.0	25.0	4.6	14.0	26.0	4.8	19.5
	6	24.3	4.5	3.5	26.0	4.8	8.0	27.5	5.0	12.5	28.7	5.2	17.0
ST-THOMAS ONTARIO	0	11.5	2.2	8.5	13.0	2.5	19.0	14.2	2.7	30.0	15.7	3.0	41.0
	2	14.7	2.8	6.5	17.0	3.2	14.0	18.75	3.5	22.0	19.8	3.7	31.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	19.0	21.5	4.0	24.5
	4	19.25	3.6	4.5	21.75	4.05	10.0	23.2	4.3	15.5	24.3	4.5	22.5
	5	21.5	4.0	4.0	23.7	4.4	8.5	25.0	4.6	13.5	26.75	4.9	20.0
	6	23.7	4.4	3.5	25.5	4.7	8.0	27.75	5.05	12.5	29.5	5.3	18.0

Note: ats is not responsible for content or accuracy of charts provided.

AREA RATING TABLE 1 (CONTINUED)

LOCATION	Roof Slope (in.)	2,500 SQ. FT. FlowRate GPM	2,500 SQ. FT. Water Depth (in.)	2,500 SQ. FT. Drain Down Time	5,000 SQ. FT. FlowRate GPM	5,000 SQ. FT. Water Depth (in.)	5,000 SQ. FT. Drain Down Time	7,500 SQ. FT. FlowRate GPM	7,500 SQ. FT. Water Depth (in.)	7,500 SQ. FT. Drain Down Time	10,000 SQ. FT. FlowRate GPM	10,000 SQ. FT. Water Depth (in.)	10,000 SQ. FT. Drain Down Time
THUNDER BAY ONTARIO	0	10.0	1.9	8.0	12.0	2.3	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	14.2	2.7	5.8	15.7	3.0	13.5	17.0	3.2	21.0	18.0	3.4	28.5
	3	16.5	3.1	5.0	18.0	3.4	11.0	19.8	3.7	18.0	20.3	3.8	24.0
	4	18.0	3.4	4.0	20.3	3.8	9.5	22.0	4.1	15.0	23.2	4.3	21.5
	5	20.3	3.8	3.5	22.5	4.2	8.0	23.7	4.4	13.0	25.0	4.6	18.0
	6	21.5	4.0	3.2	24.3	4.5	7.5	26.0	4.8	12.0	27.5	5.0	16.0
TIMMINS ONTARIO	0	11.0	2.1	8.0	13.0	2.5	18.5	14.2	2.7	29.5	15.3	2.9	40.0
	2	14.7	2.8	6.0	17.0	3.2	13.5	18.0	3.4	22.0	19.25	3.6	30.0
	3	17.0	3.2	5.0	19.25	3.6	11.5	20.3	3.8	18.5	21.5	4.0	25.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	15.5	23.7	4.4	22.0
	5	21.0	3.9	4.0	23.7	4.4	8.5	25.0	4.6	14.0	25.5	4.7	19.5
	6	23.2	4.3	3.5	25.5	4.7	7.5	27.5	5.0	12.5	28.7	5.2	17.0
TORONTO ONTARIO	0	12.0	2.3	9.0	14.2	2.7	18.4	15.3	2.9	30.0	17.0	3.2	42.0
	2	15.7	3.0	6.5	18.0	3.4	14.5	19.25	3.6	23.0	20.3	3.8	31.0
	3	18.0	3.4	5.5	20.3	3.8	12.0	21.5	4.0	19.5	22.5	4.2	26.0
	4	20.3	3.8	4.5	23.2	4.3	10.5	24.3	4.5	17.0	25.0	4.6	23.0
	5	22.5	4.2	4.0	25.0	4.6	10.0	26.0	4.8	14.5	27.5	5.0	20.5
	6	25.0	4.6	3.5	27.5	5.0	8.0	29.5	5.3	13.0	30.2	5.4	19.0
WINDSOR ONTARIO	0	12.0	2.3	9.0	13.6	2.6	19.0	14.7	2.8	29.5	15.7	3.0	41.0
	2	15.7	3.0	6.5	17.5	3.3	14.0	18.75	3.5	22.0	19.8	3.7	30.5
	3	18.0	3.4	5.5	19.8	3.7	11.5	21.0	3.9	19.0	22.0	4.1	25.0
	4	20.3	3.8	5.0	22.5	4.2	10.5	23.7	4.4	16.0	24.3	4.5	22.5
	5	22.5	4.2	4.0	24.3	4.5	9.0	26.0	4.8	14.5	26.75	4.9	20.0
	6	24.3	4.5	3.5	27.5	5.0	8.0	28.7	5.2	13.0	29.5	5.3	18.0
BRANDON (RIVERS) MANITOBA	0	12.0	2.3	8.5	13.6	2.6	19.0	14.7	2.8	30.0	15.5	2.95	40.0
	2	16.5	3.1	6.75	18.0	3.4	14.0	18.75	3.5	23.0	19.8	3.7	31.0
	3	18.75	3.5	5.5	20.3	3.8	12.0	21.5	4.0	19.0	22.0	4.1	25.5
	4	21.5	4.0	5.0	23.2	4.3	10.0	23.7	4.4	16.0	24.3	4.5	22.5
	5	23.7	4.4	4.5	25.5	4.7	9.5	26.75	4.9	15.0	27.5	5.0	20.5
	6	25.5	4.7	4.0	28.0	5.1	8.5	29.5	5.3	13.0	30.2	5.4	18.0
WINNIPEG MANITOBA	0	10.0	1.9	8.0	12.0	2.3	18.0	14.2	2.7	29.0	14.7	2.8	40.0
	2	14.2	2.7	5.8	15.7	3.0	13.5	17.0	3.2	21.0	18.0	3.4	28.5
	3	10.5	3.1	5.0	18.0	3.4	11.0	19.8	3.7	18.0	20.3	3.8	24.0
	4	18.0	3.4	4.0	20.3	3.8	9.5	22.0	4.1	15.0	23.2	4.3	21.5
	5	20.3	3.8	3.5	22.5	4.2	8.0	23.7	4.4	13.0	25.0	4.6	18.0
	6	21.5	4.0	3.2	24.3	4.5	7.5	26.0	4.8	12.0	27.5	5.0	16.0
REGINA SASKATCH-EWAN	0	9.0	1.7	7.0	11.5	2.2	17.0	13.0	2.5	28.0	14.7	2.8	40.0
	2	12.0	2.3	5.0	14.7	2.8	12.0	17.0	3.2	21.0	18.75	3.5	29.0
	3	13.2	2.55	4.0	16.5	3.1	10.0	18.75	3.5	16.0	19.8	3.7	24.0
	4	14.7	2.8	3.5	18.75	3.5	8.0	20.3	3.8	14.0	22.0	4.1	20.5
	5	15.7	3.0	2.75	19.8	3.7	7.0	22.0	4.1	12.0	24.0	4.45	17.5
	6	17.0	3.2	2.5	21.5	4.0	6.5	23.7	4.4	11.0	25.5	4.7	16.0
SASKATOON SASKATCH-EWAN	0	10.0	1.9	7.5	11.5	2.2	17.0	12.5	2.4	27.0	13.0	2.5	36.0
	2	11.5	2.2	6.0	15.3	2.9	13.0	17.0	3.2	21.0	18.0	3.4	28.0
	3	17.0	3.2	5.0	18.0	3.4	11.0	19.25	3.6	17.0	20.3	3.8	23.0
	4	19.25	3.6	4.5	20.3	3.8	9.5	21.5	4.0	14.5	22.5	4.2	20.0
	5	21.0	3.9	4.0	22.5	4.2	8.5	23.7	4.4	13.5	25.0	4.6	18.0
	6	23.2	4.23	3.5	25.0	4.6	7.5	26.0	4.8	12.0	26.75	4.9	16.0
CALGARY ALBERTA	0	10.5	2.0	8.0	12.0	2.3	17.5	13.0	2.5	27.5	13.6	2.6	37.0
	2	14.2	2.7	6.0	15.7	3.0	13.0	17.0	3.2	21.0	18.0	3.4	28.0
	3	17.0	3.2	5.0	18.0	3.4	11.0	19.25	3.6	17.0	20.3	3.8	23.0
	4	19.25	3.6	4.5	20.3	3.8	9.5	21.5	4.0	14.5	22.5	4.2	20.0
	5	21.0	3.9	4.0	22.5	4.2	8.5	23.7	4.4	13.5	25.0	4.6	18.0
	6	22.5	4.2	3.5	25.0	4.6	7.5	26.0	4.8	12.0	27.5	5.0	16.5
EDMONTON ALBERTA	0	11.0	2.1	8.0	12.5	2.4	18.5	13.6	2.6	28.5	14.7	2.8	40.0
	2	14.7	2.8	6.0	17.0	3.2	13.5	18.0	3.4	21.5	18.75	3.5	30.5
	3	17.0	3.2	5.0	18.75	3.5	11.0	20.3	3.8	17.5	21.0	3.9	24.0
	4	19.25	3.6	4.5	21.5	4.0	10.0	23.2	4.3	15.0	23.7	4.4	21.5
	5	21.0	3.9	4.0	23.7	4.4	8.5	25.0	4.6	14.5	26.0	4.8	18.5
	6	22.5	4.2	3.5	25.0	4.6	7.5	27.5	5.0	12.5	28.0	5.1	17.0
PENTICTON B.C	0	5.8	1.1	5.0	6.5	1.3	11.0	7.8	1.5	19.5	8.8	1.6	27.5
	2	9.0	1.7	3.5	10.5	2.0	8.0	11.5	2.2	14.0	12.0	2.3	20.0
	3	10.5	2.0	3.0	12.5	2.4	7.0	13.0	2.5	11.0	13.6	2.6	16.0
	4	12.0	2.3	2.5	13.6	2.6	6.0	14.7	2.8	10.0	15.7	3.0	14.0
	5	13.0	2.5	2.25	14.7	2.8	5.5	16.5	3.1	8.5	17.5	3.3	12.0
	6	13.6	2.6	2.0	15.7	3.0	5.0	18.0	3.4	8.0	18.75	3.5	11.05
VANCOUVER B.C	0	9.0	1.7	7.0	11.5	2.2	17.0	13.6	2.6	28.5	15.3	2.9	40.5
	2	11.5	2.2	5.0	14.7	2.8	12.0	17.0	3.2	21.0	18.0	3.4	28.5
	3	12.5	2.4	3.5	15.7	3.0	9.5	18.0	3.4	16.0	19.8	3.7	23.5
	4	13.6	2.6	3.0	17.5	3.3	8.0	19.8	3.7	14.0	21.5	4.0	20.0
	5	14.2	2.7	2.5	18.75	3.5	7.0	21.0	3.9	11.5	23.2	4.3	17.0
	6	14.7	2.8	2.0	19.8	3.7	6.0	22.5	4.2	9.5	25.0	4.6	15.5
VICTORIA B.C	0	8.8	16	7.0	11.5	2.2	17.0	13.0	2.5	28.0	14.7	2.8	40.0
	2	11.5	2.2	5.0	14.7	2.8	12.0	16.5	3.1	20.5	18.0	3.4	28.5
	3	12.5	2.4	3.5	15.7	3.0	9.5	18.0	3.4	16.0	19.25	3.6	23.0
	4	13.0	2.5	3.0	17.0	3.2	7.5	19.25	3.6	13.5	21.5	4.0	20.0
	5	14.7	2.8	2.5	18.75	3.5	7.0	21.0	3.9	11.5	23.2	4.3	17.0
	6	15.3	2.9	2.0	19.25	3.6	6.0	22.5	4.2	9.5	24.3	4.5	15.0

Note: ats is not responsible for content or accuracy of charts provided.

SIZING AND PLACEMENT DATA

SIZING FOR WATER HAMMER ARRESTORS

During the past years, various methods have been derived for the sizing of water hammer arresters. These varied sizing methods have created confusion among engineers, contractors and other persons engaged in the plumbing industry.

STANDARIZATION

The menbers of the Plumbing and Drainage Institute were aware of the difficulties encountered in the application of the different sizing methods. Therefore, they engaged in a research and testing program with intention of producing one standard method of sizing and placement - a method which would be of benefit to the entire plumbing industry. The final results are listed in this manual.

SYMBOLS

Before the subject of a proposed sizing method can be explained it is first necessary to devise a code of symbols for the 6 different sized units required for average plumbing systems. Each unit must have a different size and capacity to control shock in piping systems of varied size and scope. The following symbol listing has been devised to denote the range in sizes for water hammer arresters. "A", is the smallest sized unit - "F" represents the largest unit.

P.D.I. SYMBOLS: A - B - C - D -E - F

COMMENT

The P.D.I. symbols established above correspond to those units covered by the certification testing program and shall be employed with all data on sizing and placement presented in this manual.

SIZING AND PLACEMENT DATA

Single and Multiple Fixture Branch Lines
A method of sizing, based upon fixture-units has been established as most appropriate because it is quick, accurate and well known. Most engineers employ fixture-units for sizing water distribution systems.

DEFINITION OF FIXTURE UNIT

The National Plumbing Code offers this definition: "A fixture-unit is a quantity in terms of which the load producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale". The following fixture-unit table is based upon information offered in the National Plumbing Code.

TABLE IV

Fixture	Type of supply control	Weight in fixture units					
		Public			Private		
		Total	C.W.	H.W	Total	C.W.	H.W.
Water Closet	Flush Valve	10	10	-	6	6	-
Water Closet	Flush Tank	5	5	-	3	3	-
Pedestal urinal	Flush Valve	10	10	-	-	-	-
Stall or Wall Urinal	Flush Valve	5	5	-	-	-	-
Stall or wall Urinal	Flush Tank	3	3	-	-	-	-
Lavatory	Faucet	2	1 1/2	1 1/2	1	1	1
Bathtub	Faucet	4	2	3	2	1 1/2	1 1/2
Shower Head	Mixing Valve	4	2	3	2	1	2
Bathroom Group	Flush Valve Closet	-	-	-	8	8	3
Bathroom Group	Flush Valve Closet	-	-	-	6	6	3
Separate Shower	MIxing Valve	-	-	-	2	1	2
Service Sink	Faucet	3	3	3	-	-	-
Laundry Tubs (1.3)	Faucet	-	-	-	3	3	3
Combination Fixture	Faucet	-	-	-	3	3	3

Note: ats is not responsible for content or accuracy of charts provided.

NOTES

The fixture-unit values shown in the cold and hot water columns of Table IV are utilized in the sizing of water hammer arresters. Additional information on varied types of fixtures and their assigned fixture-unit values are contained in the appendix at the back of this manual.

COMMENT

These are the basic fixture-unit data which engineers utilize to size their water distribution systems. These data can be used in the sizing and placement of engineered water hammer arresters at the same time that the piping systems are sized.

SIZING AND PLACEMENT DATA

In most installations where there are several fixtures usually only one fixture valve at a time will be closed. Nevertheless, occasionally two or more fixture valves could be closed at the same instant. Table V, on sizing and selection, takes into consideration all design factors including simultaneous usage, pipe size, length, flow pressure and velocity. Table V, therefore, provides an easy, accurate method of determining the proper sived water hammer arrester for each multiple fixture branch line, and automatically provides for all factors which must be considered or otherwise calculated.

When the weight in "fixture-units" for cold and hot water branch lines serving a group of fixtures has been determined, these data can be applied to table V.

TABLE V

SIZING AND SELECTION

P.D.I. UNITS	A	B	C	D	E	F
FIXTURE UNITS	1-11	12-32	33-60	61-113	114-154	155-330

NOTE

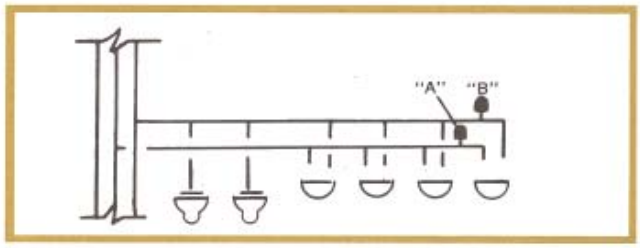
When the water pressure in the line exceeds 65 P.S.I.G., select the next larger size water hammer arrester.

If the fixture-unit total has "1/2" fraction, it is to be "rounded up" to the next larger or whole number. Thus, if total is 11 1/2 fixture-units, charge it to 12 fixture-units.

All sizing data in this manual are based on flow velocities of 10 F.P.S. or less.

SIZING FOR WATER HAMMER ARRESTERS

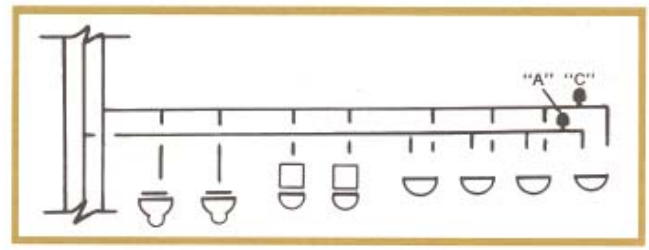
EXAMPLE Table V will permit engineers and contractors to select the proper water hammer arrester for each application. The following examples show the relative ease with which sizing can be accomplished using Tables IV and V.



EXAMPLE 1

Cold Water Branch
2 wc. at 10 F.U. ea. = 20
4 Lav. at 1 1/2 F.U. ea. = 6
Total 26
Select P.D.I. "B" unit

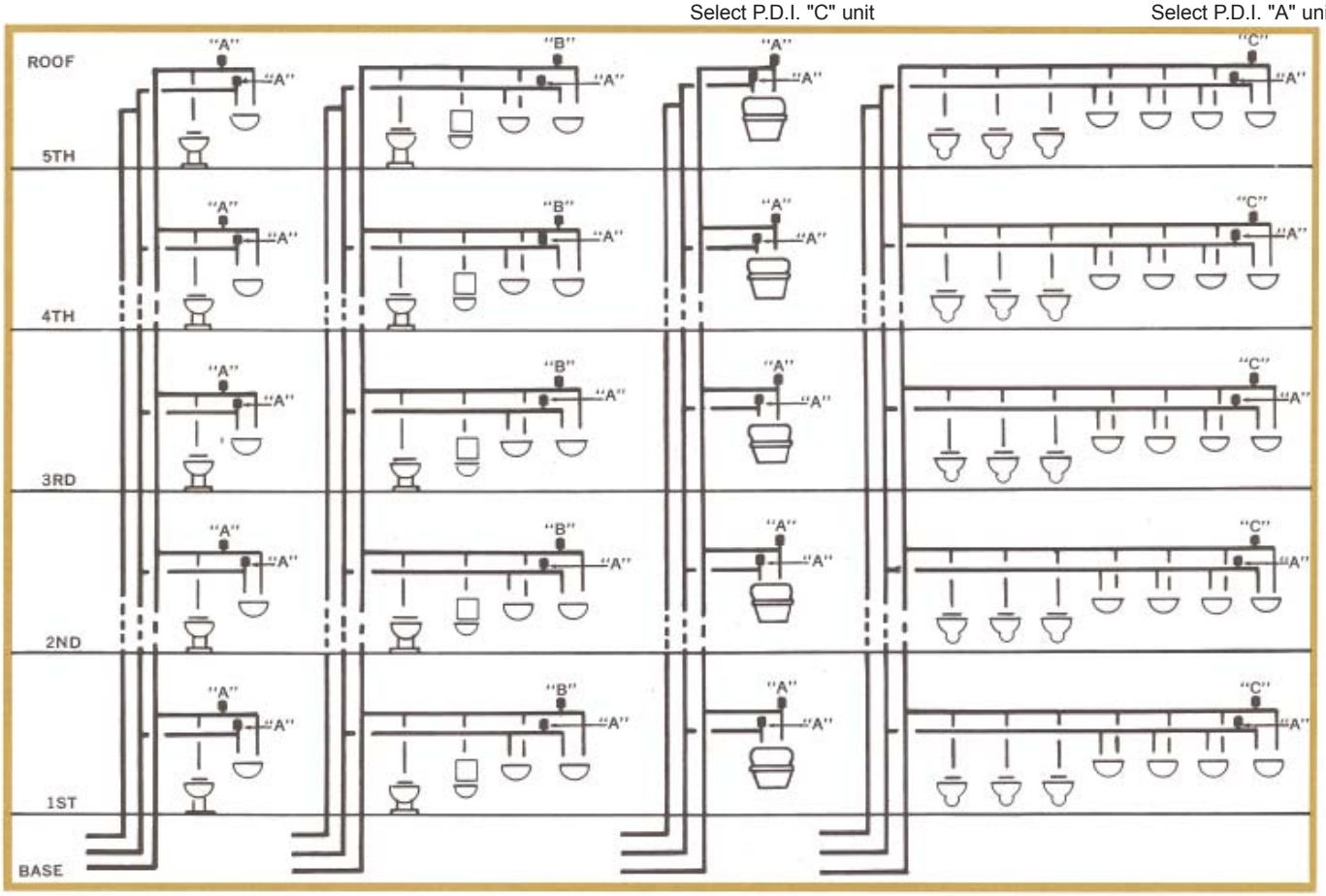
Hot Water Branch
4 Lav. at 1 1/2 ea. = 6
Total 6
Select P.D.I. "A" unit



EXAMPLE 2

Cold Water Branch
2 wc. at 10 F.U. ea. = 20
2 Ur. at 5 F.U. ea. = 10
4 Lav. at 1 1/2 F.U. ea. = 6
Total 36
Select P.D.I. "C" unit

Hot Water Branch
4 Lav. at 1 1/2 F.U. ea. 6
Total 6
Select P.D.I. "A" unit



EXAMPLE

It is relatively easy to select the proper sized water hammer arrester for a multiple fixture branch. Fig. 17 represents a typical riser diagram of the type that an engineer may include with his/her set of drawings.

When sizing the cold and hot water branch lines, it is usual practice to obtain the total number of fixture units on each branch line. This information is then applied to sizing charts to determine the required size of branch lines.

The proper sized water hammer arresters can be selected once the total of fixture-units for a cold or hot water branch is known. It is only necessary to apply the fixture-units to Table V and select the appropriate water hammer arrester.

It is suggested that the engineers employ P.D.I. symbols for his/her riser diagrams, as shown in the illustration above. This practice will enable manufacturers to furnish the correct units.

Note: ats is not responsible for content or accuracy of charts provided.

SIZING FOR WATER HAMMER ARRESTERS

It has been established that the preferred location for the water hammer arrester is at the branch line between the last two fixtures served. This location is shown in Fig. 18.

SIZING AND PLACEMENT DATA

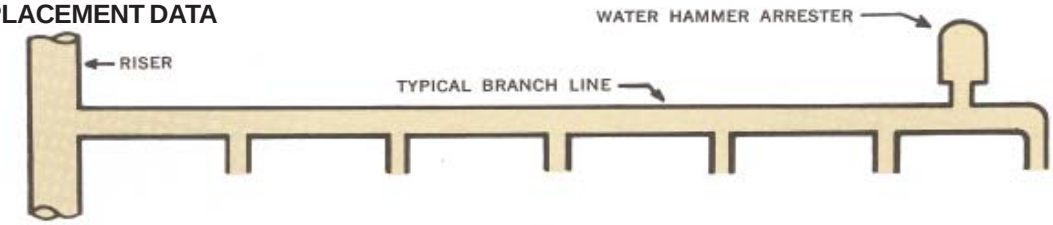


FIG. 18

This location of the water hammer arresters shownin Fig. 18 applies to branch lines that do not exceed 6.1m in length, from the start of the horizontal branch line to the last fixture supply on this branch line. When the branch line exceeds the 6.1m in length, an additional water hammer arrester should be used. This practice is best defined by two rules which have been established to cover the placement of water hammer arresters. These rules are explained below.

RULE 1

Rule 1, covers multiple fixture branch lines which do not exceed 6.1m in length.

EXPLANATION - Fixture-unit sizing Table V is used to select the required P.D.I. unit.
See example

RULE 2

Rule 2, covers multiple fixture branch lines which do exceed 6.1m in length.

EXPLANATION - Fixture-unit sizing Table V is used to select the required P.D.I. unit. The sum of the F.U. ratings of units X and Y shall be equal to or greater than the demand of the branches.
See example

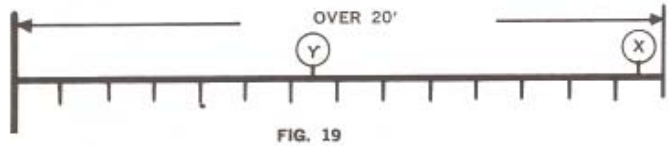
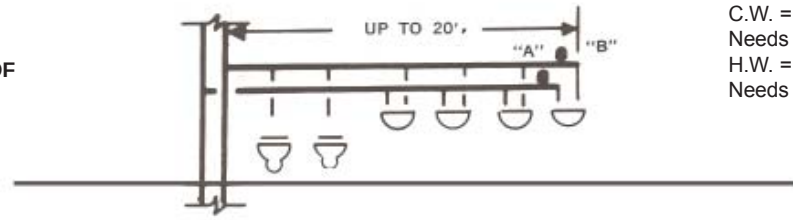


FIG. 19

EXAMPLES

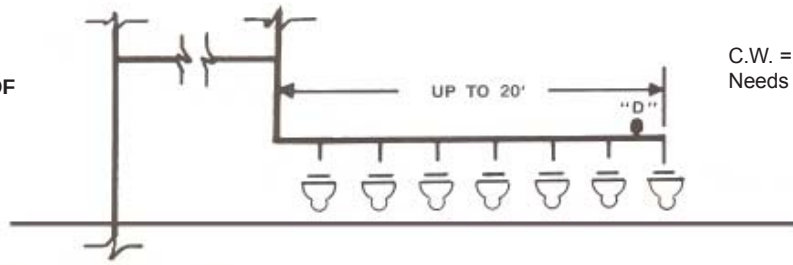
Showing typical applications for Rule 1 and Rule 2.

EXAMPLE OF RULE 1



C.W. = 26 F.U.
Needs - P.D.I. "B" unit
H.W. = 6 F.U.
Needs - P.D.I. "A" unit

EXAMPLE OF RULE 2



C.W. = 70 F.U.
Needs - P.D.I. "D" unit

Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.

SIZING OF WATER SYSTEMS

CHART A-2
Estimated Curves for Demand Load

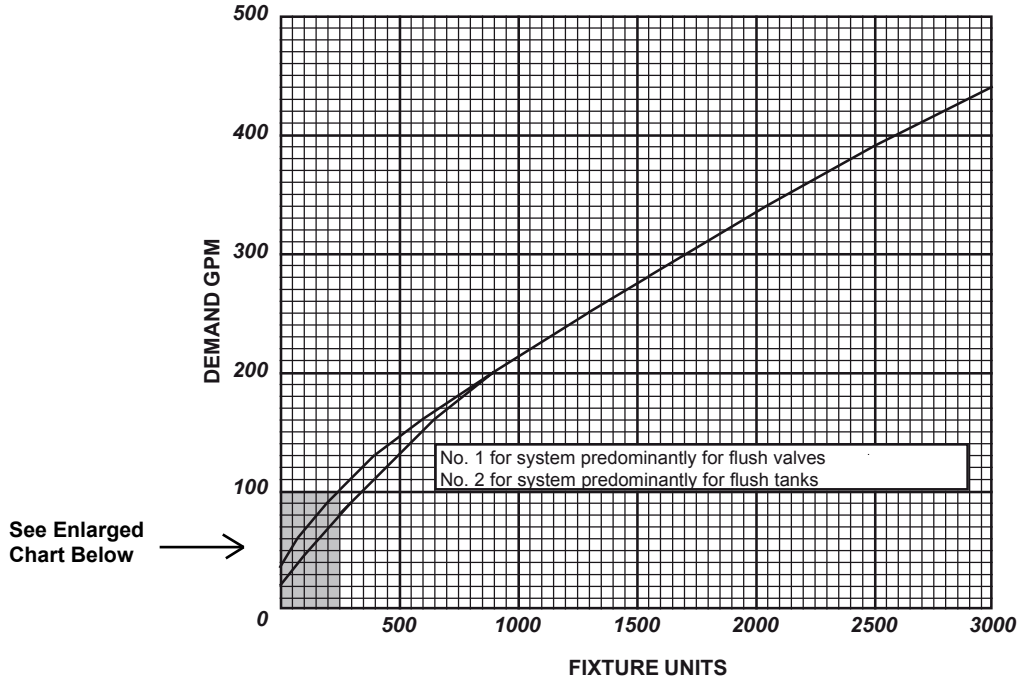
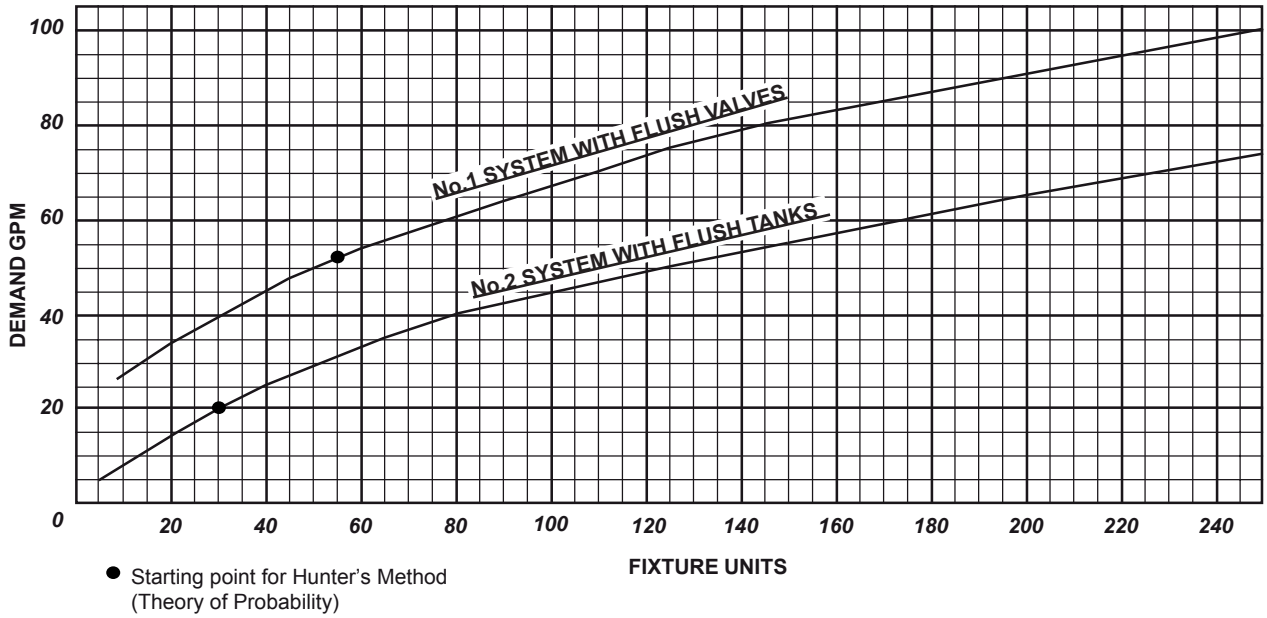


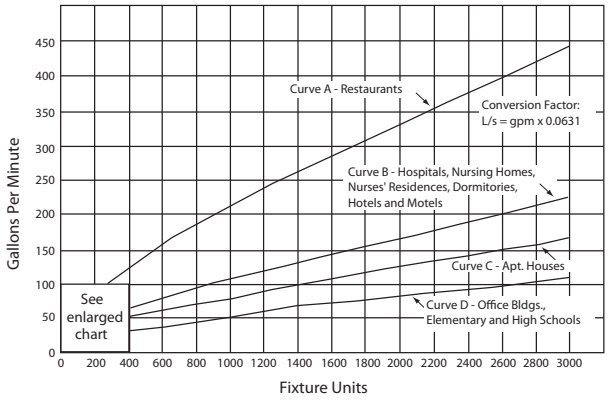
CHART A-3
Enlarged Scale Demand Load



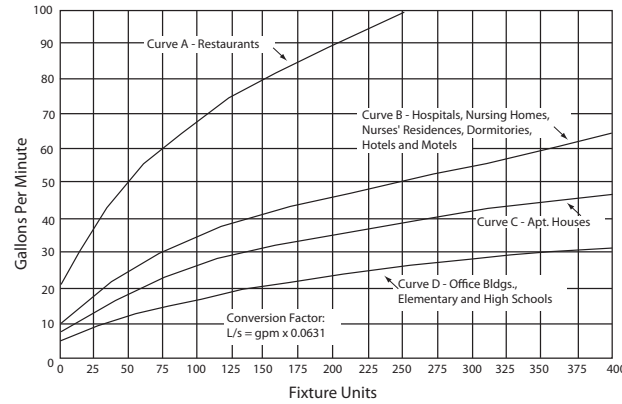
For Hot Water sizing see also ASHRAE modified Hunters Curve Drawing No.19-18A

Note:
-Consult your local plumbing codes for sizing information
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

ASHRAE Modified Hunter Curve - Flow Charts



Enlarged Section



CONVERSION FACTOR
L/s = gpm x 0.0631

Hot Water Flow Rate 140 deg. F
(Data predates low-flow fixtures)

Fixture	Type of supply control	Weight in fixture units					
		Public			Private		
		Total	C.W.	H.W.	Total	C.W.	H.W.
Water Closet	Flush Valve	8	8	-	6	6	-
Water Closet	Flush Tank	4	4	-	3	3	-
Stall or Wall Urinal	Flush Valve	4	4	-	-	-	-
Lavatory/Basin	Faucet	2	1	1	1	0.75	0.75
Bathtub	Faucet	3	2	2	2	1	1
Shower	Mixing Valve	3	2	2	2	1.5	1.5
Bathroom Group	Flush Valve Closet	-	-	-	7	6	2
Bathroom Group	Flush Tank Closet	-	-	-	5	3	2
Service Sink	Faucet	3	2.5	2.5	-	-	-
Laundry Tubs (1.2)	Faucet	3	2	2	3	2	2
Kitchen Sink (1 comp.)	Faucet	3	2	2	2	1.5	1.5
Kitchen Sink (2 / 3 compartment)	Faucet	4	2.5	2.5	-	-	-
Bar Sink	Faucet	2	1	1	1	0.75	0.75
Dishwasher	Service Stop	3	-	3	-	-	-
Washfountain	4 Person Faucet	2	1.5	1.5	-	-	-

Note:
• This revision to chart is done to suit low-flow fixtures for both hot and cold water (as shown in the above charts). Consult local codes for acceptance.
• For data predating low-flow fixtures refer to Table IV Dwg. 19-15
• For original Hunter Curve see Dwg. 19-18

Note:
-Consult your local plumbing codes for sizing information and acceptance of revised data for low-flow fixtures
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

VARIOUS FORMULAS FOR WATER HEATING CALCULATIONS

$$\%\ \text{Efficiency} = \frac{\text{GPH X 8.25 X Temp. Rise X 1.0}}{\text{Btu/Hr. Input}}$$ (1.0 = Specific Heat)

$$\text{Btu/Output} = \text{GPH X 8.25 Lbs./Gal. X Temp. Rise X 1.0}$$

$$\text{Btu/Input} = \frac{\text{GPH X 8.25 X Temp. Rise X 1.0}}{\%\ \text{Efficiency}}$$

$$\text{Gal/Per/Hr.} = \frac{\text{Btu/Hr. Input X \% Efficiency}}{\text{Temp. Rise X 8.25}}$$

$$\text{Rise (°F)} = \frac{\text{Btu/Hr. Input X \% Efficiency}}{\text{GPH X 8.25}}$$

$$\text{KW} = \frac{\text{GPH X 8.25 X Temp. Rise X 1.0}}{3413} \text{ (OR) } \frac{\text{GPH X Temp. Rise}}{414}$$

$$\text{Gal/Per/Hr.} = \frac{\text{KW X 3413}}{\text{Temp. Rise X 8.25}} \text{ (OR) } \frac{\text{KW X 414}}{\text{Temp. Rise}}$$

$$\text{Rise (°F)} = \frac{\text{KW X 3413}}{\text{GPH x 8.25}} \text{ (OR) } \frac{\text{KW X 414}}{\text{GPH}}$$

1 KW = 3413 Btu = 4.1 Gals. @ 100°F Rise

1 KW = 1,000 Watts Btu X 0.293 = Watts

Determine % of hot water portion of total mixed water 'M' requirements

$$\frac{\text{M-C}}{\text{H-C}} = \frac{140-40}{180-40} = \frac{100}{140} = 71.5\%\ \text{of mixture is hot water}$$

% of cold water in mixture is:

$$\frac{\text{H-M}}{\text{H-C}} = \frac{180-140}{180-40} = \frac{40}{140} = 28.5\%\ \text{of mixture is cold water.}$$

1 Ø

$$\frac{\text{Watts}}{\text{Volts}} = \text{Amps}$$

Volts X Amps = Watts

3 Ø (Balanced Circuits)

$$\frac{.577 \text{ X Watts}}{\text{Volts}} = \text{Amps}$$

Volts X Amps X 1.73 = Watts

PERCENTAGE OF 180°F PREHEATED WATER TO MIXING VALVE FOR SELECTED MIXED WATER TEMPERATURES

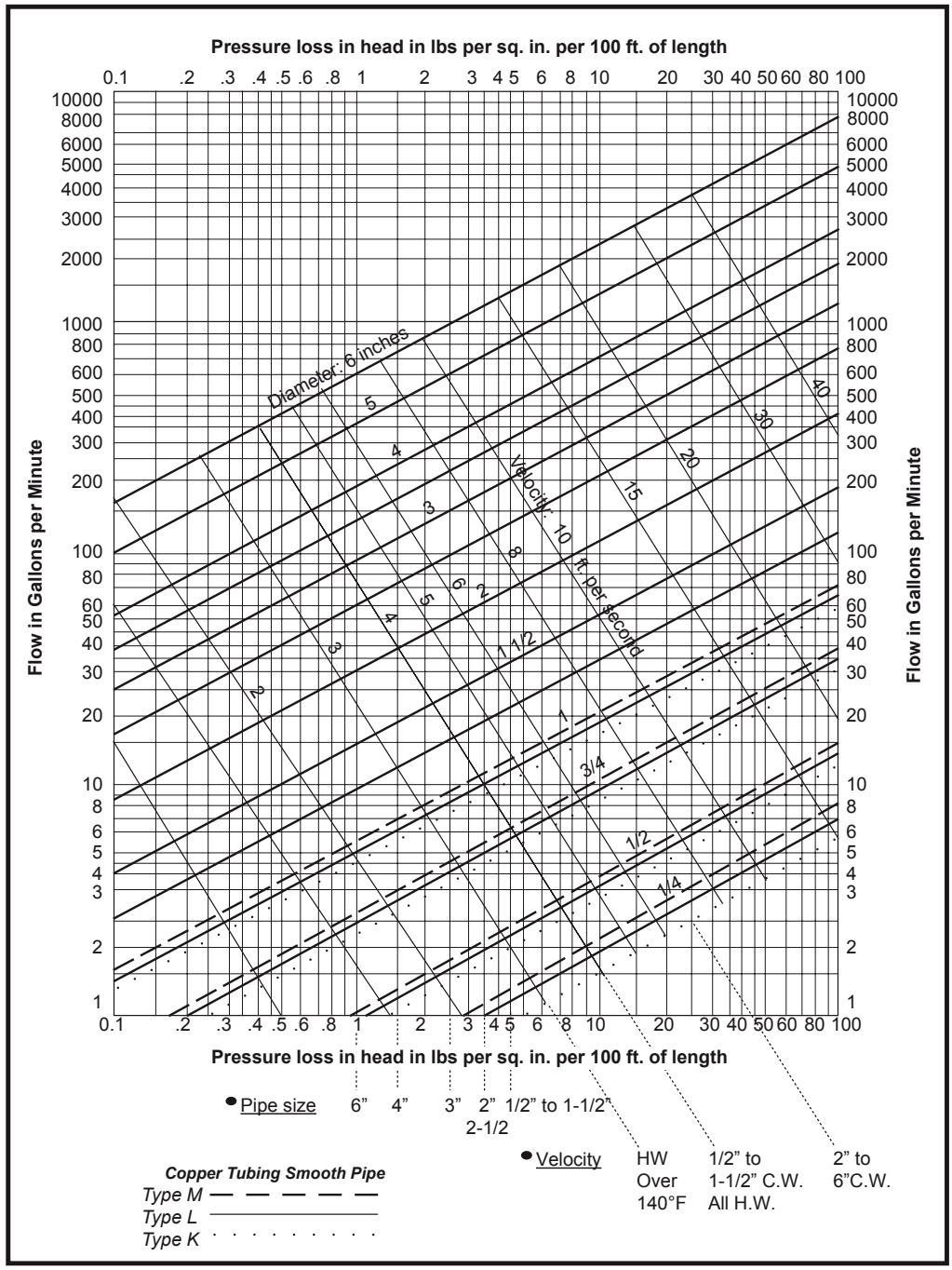
Desired Mixed Temperature	% of 180°F Water For Each Cold Supply Temperature						
°F	40°	50°	60°	70°	80°	90°	100°
180	—	—	—	—	—	—	—
170	92.8	92.3	91.7	90.9	90	88.8	87.5
160	86	85	83.3	82	80	78	75
150	78.5	76	75	73	70	67	68.5
140	71	69	67	64	60	55.5	50
130	65	61.5	58	54.5	50	44	37.5
120	57	54	50	45	40	33	25
110	50	46	41.5	36	30	21	12
100	43	38	33	27	20	11	—

Example: 1) Desired mixed outlet water temperature = 140°F 71% of hot water @ 180°F
2) Hot water supply (stored water temp) = 180°F 29% of cold water @ 40°F
3) Cold water supply = 40°F 100% mixed water @ 140°F

Note:
-Consult your local plumbing codes for sizing information and acceptance of revised data for low-flow fixtures
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

PIPE SIZING DATA

CHART A-4



■ B.C. Code:
C.W. 5ft/sec
H.W. 4ft/sec
H.W. over 140°F 3 ft/sec

● Revised table to suit velocities obtained from copper pipe assoc. hand book.
(See also main sizing Drawing No. 19-21)

Note:
-Consult your local plumbing codes for sizing information
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

COLD WATER SYSTEMS
FIXTURE UNITS versus GPM

Conversion table
Flow in Gallons per Minute versus Water Fixture Units

	Flow GPM (US)	Fixture Units	
		Flush Tank	Flush Valve
	1	0	-
	2	1	-
	3	3	-
	4	4	-
	5	6	-
	6	7	-
	7	8	-
	8	10	-
	9	12	-
	10	13	-
	11	15	-
	12	16	-
	13	18	-
	14	20	-
	15	21	-
	16	23	-
	17	24	-
	18	26	-
	19	28	-
	20	30	-
	21	32	-
	22	34	5
	23	36	6
	24	39	7
	25	42	8
	26	44	9
	27	46	10
	28	49	11
	29	51	12
	30	54	13
	31	56	14
*	32	58	15
	33	60	16
	34	63	18
	35	66	20
	36	69	21
	37	74	23
	38	78	25
	39	83	26
	40	86	28
	41	90	30
	42	95	31
	43	99	33
	44	103	35
	45	107	37
	46	111	39
	47	115	42
	48	119	44
	49	123	46
	50	127	48
	51	130	50
	52	135	52
	53	141	54
	54	146	57
*	55	151	60
	56	155	63
	57	160	66
	58	165	69
	59	170	73
	60	175	76
	62	185	82
	64	195	88
	66	205	95
	68	215	102
	70	225	108
	72	236	116
	74	245	124
	76	254	132
	78	264	140
	80	275	148
	82	284	158
	84	294	168
	86	305	176
	88	315	186
	90	326	195
	92	337	205
	94	348	214
	96	359	223
	98	370	234
	100	380	245
	105	406	270
	110	431	295
	115	455	329
	120	479	365
	125	506	396
	130	533	430
	135	559	460
	140	585	490
	145	611	521
	150	638	559
	155	665	596
	160	692	631
	165	719	666
	170	748	700
	175	778	739
	180	809	775
	185	840	811
	190	874	850
	200	945	931
	210	1018	1009
	220	1091	1091
	230	1173	1173
	240	1254	1254
	250	1335	1335
	260	1418	1418
	270	1500	1500
	280	2583	2583
	290	1668	1668
	300	1755	1755
	310	1845	1845
	320	1926	1926
	330	2018	2018
	340	2110	2110
	350	2204	2204
	360	2298	2298
	370	2388	2388
	380	2480	2480
	390	2575	2575
	400	2670	2670
	410	2765	2765
	420	2862	2862
	430	2960	2960
	440	3060	3060
	450	3150	3150
	500	3620	3620
	550	4070	4070
	600	4480	4480
	700	5380	5380
	800	6280	6280
	900	7280	7280
	1000	8300	8300

* Min. probability for use with Hunter Curve

Note:
-Consult your local plumbing codes for sizing information
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

SIZE OF STACKS FOR APT. BLDGS.

BATHROOM GROUP					2 BATHROOMS GROUP			
NO.	TL FU	CW	HW	w	CW	HW	w	
1	6	3/4"	1/2"	3"	3/4"	3/4"	3"	
2	12	1"	3/4"		1-1/4"	1"		
3	18	1-1/4"	1"		1-1/2"	1-1/4"		
4	24	1-1/2"	1-1/4"		1-1/2"	1-1/2"	4"	
5	30	1-1/2"	1-1/4"		2"	1-1/2"		
6	36	2"	1-1/2"	4"	2"	1-1/2"		
7	48	2"	1-1/2"		2"	2"		
8	54	2"	1-1/2"		2"	2"		
9	60	2"	2"		2-1/2"	2"		
10	66	2"	2"		2-1/2"	2-1/2"		
11	72	2"	2"		2-1/2"	2-1/2"		
12	78	2-1/2"	2"	4"	2-1/2"	2-1/2"	4"	

COLD WATER		HOT WATER	
FU	SIZE	FU	SIZE
4-1/2	3/4"	3	3/4"
9	1"	6	3/4"
13-1/2	1"	9	1"
18	1-1/4"	12	1"
22-1/2	1-1/4"	15	1-1/4"
27-1/2	1-1/2"	18	1-1/4"
31-1/2	1-1/2"	21	1-1/4"
36	1-1/2"	24	1-1/4"
40-1/2	2"	27	1-1/2"
45	2"	30	1-1/2"
49-1/2	2"	33	2"
54	2"	36	2"
58-1/2	2-1/2"	38	2"

KITCHEN SINK					2 KITCHEN SINKS				
NO.	TL FU	CW	HW	W	NO.	TL FU	CW	HW	W
1	2	3/4"	3/4"	2"	1	4	3/4"	3/4"	2"
2	4	3/4"	3/4"		2	8	1"	1"	
3	6	3/4"	3/4"		3	12	1"	1"	
4	8	1"	1"		4	16	1"	1"	
5	10	1"	1"		5	20	1-1/4"	1-1/4"	
6	12	1"	1"	3"	6	24	1-1/4"	1-1/4"	
7	14	1-1/4"	1-1/4"		7	28	1-1/4"	1-1/4"	3"
8	16	1-1/4"	1-1/4"		8	30	1-1/2"	1-1/2"	
9	18	1-1/4"	1-1/4"		9	34	1-1/2"	1-1/2"	
10	20	1-1/2"	1-1/2"		10	38	1-1/2"	1-1/2"	
11	22	1-1/2"	1-1/2"		11	42	2"	2"	
12	24	1-1/2"	1-1/2"	3"	12	46	2"	2"	3"

● MAIN FU (GPM) CW HW	● MAIN FU (GPM) CW HW
3/4"	3"
6 (7) ---------- 6 (7)	650 (155) ---------- 400 (110)
1"	4"
18 (14) ---------- 18 (14)	1475 (270) ---------- 850 (190)
1-1/4"	6"
40 (25) ---------- 30 (21)	4000 (550) ---------- 2625 (400)
1-1/2"	
70 (36) ---------- 50 (28)	
2"	
210 (67) ---------- 125 (50)	
2-1/2"	
375 (105) ---------- 255 (75)	

- Revised to suit velocities obtained from copper pipe assoc. handbook.

  Refer also to sizing data Dwg. No.19-19

Note:
-Consult your local plumbing codes for sizing information
- In the absence of other guidance, the above date is provided
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SIZING OF HOT WATER STORAGE TANK

TOTAL THE NUMBER OF INDIVIDUAL FIXTURES FOR A BUILDING AND ALLOW NUMBER OF GALS. PER HOUR AS REQUIRED BY FOLLOWING CHART.
REFER ALSO TO ASHRAE MODIFIED HUNTERS CURVE DWG. NO. 19-18A

HOT WATER FIXTURE CAPACITIES FOR VARIOUS TYPES OF BLDGS.

U.S. GALLONS OF HOT WATER PER HR. (LPH) FIXTURE AT A FINAL TEMP. OF 140 DEGREES F.

Note: Data predates modern low-flow fixtures and appliances.

GPH LPH F.U. (140 ° F water)	PRIVATE RES.	APT. HOUSE *	CLUB	GYM	HOSPITAL	HOTEL	IND. PLANT	OFFICE	PUBLIC BATH	SCHOOL	YMCA
FIXTURE											
BASIN (Private Lav.)	2 7.6 -	2 7.6 0.75	2 7.6 0.75	2 7.6 0.75	2 7.6 0.75	2 7.6 0.75	2 7.6 0.75	2 7.6 0.75	2 7.6 -	2 7.6 0.75	2 7.6 0.75
BASIN (Public Lav.)	- - -	4 15 -	6 23 1	8 30 1	6 23 1	8 30 1	12 46 1	6 23 1	12 46 1	15 57 1	8 30 1
BATH TUBS	20 76 -	20 76 1.5	20 76 1.5	30 114 -	20 76 1.5	20 76 1.5	30 114 -	- - -	45 171 1.5	- - -	30 114 -
DISH WASHER	15 57 -	15 57 1.5	50-150 190-570 Five fixture units per 250 seating capacity	- -	50-150 190-570	50-200 190-760	20-100 76-380	- -	- -	20-100 76-380	20-100 76-380
FOOT BATH (Res.)	3 11 -	3 11 -	3 11 -	12 46 -	3 11 -	3 11 -	12 46 -	- - -	- - -	3 11 -	12 46 -
KITCHEN SINK	10 38 -	10 38 0.75	20 76 1.5	- - -	20 76 3	20 76 1.5	20 76 3	- - -	- - -	10 38 0.75	20 76 3
LAUNDRY TUB	20 76 1.5	20 76 1.5	28 106 -	- - -	28 106 -	28 106 -	- - -	- - -	- - -	20 76 2.5	28 106 -
PANTRY SINK	5 19 -	5 19 -	10 38 2.5	- - -	10 38 2.5	10 38 2.5	- - -	- - -	- - -	10 38 2.5	10 38 2.5
SHOWER	30 114 -	30 114 1.5	105 568 1.5	223 850 1.5	75 284 1.5	75 284 1.5	223 850 3.5	30 114 -	223 850 -	223 850 1.5	223 850 1.5
SLOP SINK	15 57 -	20 76 1.5	20 76 2.5	- - -	20 76 2.5	30 114 2.5	20 76 2.5	15 57 2.5	15 57 2.5	20 76 2.5	20 76 2.5
HOURLY HEATING CAPACITY FACTOR	30%	30%	30%	40%	25%	25%	40%	30%	50%	40%	40%
STORAGE CAPACITY FACTOR	70%	125%	90%	100%	60%	80%	100%	200%	120%	100%	100%

HOURLY HEATING CAPACITY = Hourly Required x Hourly Heating Factor
STORAGE CAPACITY = Hourly Capacity x Storage Factor
STORAGE TANK USABLE WATER IS 70%

***** Apartment demand - 3hrs
Dorm demand - 1-2 hrs
Schools - add additional showers for evening classes/activities

****** For low-flow faucets deduct 30% from amounts shown. (See note)

******* For high efficience electronic 'No Touch' faucets deduct 50% from amounts shown. (See note)

Note:
-Consult your local plumbing codes for sizing information and acceptance of revised data for low-flow fixtures
- In the absence of other guidance, the above date is provided
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QUICK STICK METHOD

	NO. SUPPLY	1	2	3	4	5	8	9	10	11	12	14	16	20
*	TOILET / URINAL TANK	1/2	3/4	3/4	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2
*	TOILET / URINAL FLUSH VALVE	1	1-1/2	1-1/2	2	2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	3
	Basin	1/2	1/2	3/4	3/4	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2
	COMB. HOT & COLD	1/2	1/2	1/2	3/4	3/4	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2
	SHOWER / SLOP SINK	1/2	3/4	1	1	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	2	2
	STEAM 15 P.S.I.G.	1	1	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	2	2	2	2	2
	AIR GAS PER 100'	1 TO 5 1/2		6 TO 16 3/4		17 TO 30 1		31 TO 50 1-1/4		51 TO 90 1-1/2		91 TO 180 2	181 TO 285 2-1/2	286 TO 430 3

- Revised to suit Low Flow fixtures and velocities (2011)
  Refer also to revised table Dwg. No.19-19

	SIZE OF PIPE HOT OR COLD WATER		FIXTURE UNITS	
*	TOILET/URINAL (T)	4 F.U.	SHOWER HD.	1-1/2
*	TOILET/URINAL (FV)	6	BATH TUB	1-1/2
	BASIN	1	LAUNDRY TUB	2
	SLOP SINK	2-1/2	2 / 3 COMP SINK	2 / 2-1/2
	WASHFOUNTAIN	4	WALL HYDRANT	3

1/2	1 TO 2
3/4	3 TO 6
1	7 TO 18
1-1/4	19 TO 30
1-1/2	31 TO 50
2	51 TO 125
2-1/2	126 TO 255
3	256 TO 400
4	401 TO 850
6	851 TO 2625

SIZE OF VENT	LOU	UNITS
TOILET	1-1/2 VENT	4 L.U.
URINAL	1-1/2	2
BASIN	1-1/4	1
SINK	1-1/2	2
FLOOR DRAIN	1-1/2	2

1-1/4 BASIN	1	TO	4
1-1/2	5	TO	12
2	13	TO	50
2-1/2	51	TO	64
3	65	TO	100
4	101	TO	200
6	201	TO	400
8	401	TO	800
10	801	TO	1200
12	1201	TO	1600

* Use min. size for flush valve as shown in Quick Stick method.

Note:
-Consult your local plumbing codes for sizing information and acceptance of revised data for low-flow fixtures
- In the absence of other guidance, the above date is provided
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GREASE INTERCEPTOR SIZING

GENERAL PROCEDURE

To determine the flow rate of each sink:
a) Calculate capacity of sink in cubic inches, length x width x depth.
b) Convert capacity from cubic inches to US GPM, capacity divided by 231.
c) Multiply by .75 for displacement.
d) Resulting figure is flow rate required to drain sink in one minute.

NOTE: If flow rate of the pipe draining the sink is smaller than the calculated flow rate, use smaller number.

EXAMPLE: 3 Compartment Sink Each Compartment 12" x 15" x 12"
12" x 15" x 12" = 2160 cu. in. x 3 = 6480 cu. in.
6480 : 231 = 28 US GPM
28 x .75 = 21 US GPM

20 GPM Interceptor would drain sink in slightly more than one minute.

Discharge from spray hoods should be determined by the flow rate of the hood.
Discharge from the dishwashers should be determined by the discharge pump rate.

SIZING FOR MULTIPLE FIXTURES

a) Determine flow rate from each fixture to be serviced be the grease interceptor.
b) Add to the largest flow rate, 50% of the second largest and 25% of all others.
c) Total of b) will be flow rate of the interceptor.

EXAMPLE:

		RATED FLOW
Fixture A	=	35 GPM
Fixture B	=	26 GPM
Fixture C	=	18 GPM
Fixture D	=	12 GPM

Largest flow 35 GPM
2nd Largest, 50% of 26 = 13 GPM
3rd and 4th, 25% of 18 + 12= 7.5 GPM

55.5 GPM

Interceptor with 50 GPM flow rate should be selected.

Ontario Building Code 1997 7.4.4.3.

(7) A grease *interceptor* shall be located as close as possible to the *fixture* or *fixtures* it serves.

(8) The flow rate through a grease *interceptor* shall not exceed its rated capacity and the flow rate shall be determined using the following:

$$Q = \left(\sum_{1}^{N} \left(0.75 \frac{V}{DDT}\right)\right) + PD$$

Where Q is the flow rate to a grease *interceptor* in L/s.
Where V is the volume of the *fixture* in *l*.
Where DDT is the drain down time, 60 or 120 seconds (1 or 2 minutes)
Where PD is any pump discharge on L/s.
Where N is the number of *fixutres* to go through the *interceptor*.

(9) All grease and oil *interceptors* shall have an internal flow control and where the head will exceed five feet, a secondary flow control shall be required.

(10) Floor drains that conform to Sentence 7.4.5.1.(3) are not required to be separately trapped and vented, and may be gang trapped when discharging through an oil *interceptor*.

Note: - Consult your local plumbing codes for sizing information.
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FU. / DRAIN SIZE / WATER SIZE FOR PLUMBING FIXTURES

LOAD FACTORS OF FIXTURES

Column 1	Column 2
Fixture	No. of fixture-units
Bath room group, consisting of 1 water closet, 1 wash basin and 1 bath tub or shower stall	8
Bath tub with or without overhead shower	1-1/2
Bed Pan Washer	6
Bidet	1-1/2
Combination of sink and laundry tray	2
Combination of sink and tray with food disposal unit	4
Cuspidor or dental unit	1
Dental lavatory	1
Dish washer, domestic type	1-1/2
Drinking fountain	1
Floor drain	3
Household ice box	1
Kitchen sink,	1
(a) two-compartment	3
(b) Three-compartment	4-1/2
Two or three compartment Laundry tray	1-1/2
Shower stall	1-1/2
Showers in a group, each head	1-1/2
Sinks	
(a) flushing rim, with valve	6
(b) pot, scullery	4
(c) service, trap standard type	3
(d) service, P-trap type	2
(e) surgeon's	3
Urinals	
(a) pedestal, siphon-jet or blow out type	4
(b) stall, wash-out type	2
(c) wall, lip type	1-1/2
Wash basin	
(a) 1-1/4 inch trap	1
(b) 1-1/2 inch trap	1-1/2
Wash sink, circular or multiple type, each set of faucets	2
Water-closet	
(a) tank operated	6
(b) valve operated	8
Beer dispenser	1-1/2
Dead fish tank	1-1/2
Domestic washing machine	1-1/2
Dish washer commercial	4
Potato and vegetable washers and peeler	4
Glass washer commercial	4
Cocktail mixing unit	1-1/2
Small labratory sinks	1

MINIMUM SIZES OF TRAPS AND OUTLET-CONNECTIONS FOR FIXTURES

Column 1	Column 2
Fixture	Minimum trade size of trap and fixture-outlet connection, in inches
Bath tub with or without overhead shower	1-1/2
Beer Cabinet	1-1/2
Bedpan Washer	3
Bidet	1-1/4
Combination of sink and laundry tray	1-1/2
Cuspidor or dental unit	1-1/4
Dental lavatory	1-1/4
Dish washer, domestic type	1-1/2
Drinking fountain	1-1/4
Floor drain	2
Two or three compartment laundry tray	1-1/2
Refrigerator	1-1/4
Shower stall	1-1/2
Sinks	
(a) flushing rim with valve	3
(b) kitchen, domestic type	1-1/2
(c) pot, scullery	1-1/2
(d) service, with P-trap	2
(e) service, with trap-standard	3
(f) surgeon's	1-1/2
Urinals	
(a) blow out, pedestal, or siphon jet type	3
(b) stall	2
(c) wall	1-1/2
Wash basin	1-1/4
Wash sink, circular or multiple	1-1/2
Water-closet	3
Beer Dispenser	1-1/2
Dead fish tank	1-1/2
Domestic washing machine	1-1/2
Dish washer commercial	2

MINIMUM SIZES OF WATER SUPPLY PIPES TO FIXTURES

Column 1	Column 2
Fixture	Pipe, trade size, in inches
Bath tub	1/2
Combination of sink and laundry tray	1/5
Dish washer, domestic type	1/2
Drinking fountain	3/8
Hose connection	1/2
Hot water boiler	1/2
Laundry tub 1,2, or 3, compartments	1/2
Shower, single head	1/2
Sink	1/2
Urinal	1/2
Wash basin	3/8
Water-closet, tank type	3/8
Water-closet, flush-valve type	1

Note: - Consult your local plumbing codes for sizing information.
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STACK & BRANCH SIZING
BUILDING SOIL DRAIN SIZING

SIZES OF HORIZONTAL BRANCHES

Column 1	Column 2
Branch piping, trade size, in inches	Maximum load, in fixture-units
1-1/4	2
1-1/2	3
2	6
2-1/2	12
3	30
4	160
~~5~~	~~360~~
6	620
8	1,400
10	2,500
12	3,900
15	7,000

SIZES OF STACKS NOT EXCEEDING 3 STOREYS

Column 1	Column 2
Pipe, trade size, in inches	Maximum load, in fixture-units
1-1/4	3
1-1/2	4
2	10
2-1/2	20
3	50
4	240
~~5~~	~~540~~
6	960
8	2,200
10	3,800
12	6,000

SIZES FOR STACKS MORE THAN 3 STOREYS

Column 1	Column 2	Column 3
Stack trade size, in inches	Maximum total load for stack in fixture-units	Maximum load at 1 storey in fixture-units
1-1/4	3	2
1-1/2	8	3
2	24	6
2-1/2	42	9
3	60	16
4	500	90
5	1,100	200
6	1,900	350
8	3,600	600
10	5,600	1,000
12	8,400	1,500

MAXIMUM HYDRAULIC LOAD FOR BUILDING DRAINS OR BUILDING SEWERS

Column 1	Column 2	Column 3	Column 4	Column 5
Drain or sewer pipe, trade size, in inches	Maximum load for slope of 1/14 inch, a foot of run, in fixture-units	Maximum load for slope of 1/8 inch, a foot of run, in fixture-units	Maximum load for slope of 1/4 inch, a foot of run, in fixture-units	Maximum load for slope of 1/2 inch, a foot of run, in fixture-units
4	....	180	216	250
5	....	390	480	575
6	....	700	840	1,000
8	1,400	1,600	1,920	2,300
10	2,500	2,900	3,500	4,200
12	3,900	4,600	5,600	6,700
15	7,000	8,300	10,000	12,000

Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
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VENT SIZING

106.--(1) A branch vent, vent stack or stack vent of 1-1/4 inch trade size shall have connected to it not more than four vent pipes of 1-1/4 inch, trade size.

(2) A branch vent, vent stack or stack vent of 1-1/2 inch, trade size shall have connected to it not more than,

(a) twelve vent pipes of 1-1/4 inch, trade size;

(b) six vent pipes of 1-1/2 inch, trade size, other than water-closet vent pipes;

(c) two water-closet vent pipes of 1-1/2 inch, trade size; or

(d) one water-closet vent pipe of 1-1/2 inch, trade size, and four other vent pipes of 1-1/4 inch, trade size.

(3) A loop vent, circut vent, relief vent, branch vent, vent stack, or stack vent of 2 inch trade size shall have connected to it not more than,

(a) fifty vent pipes of 1-1/4 inch, trade size;

(b) twenty-five vent pipes of 1-1/2 inch, trade size, other than water-closet vent pipes; or

(c) six water-closet vent pipes of 1-1/2 inch, trade size, and

(i) twelve other vent pipes of 1-1/2 inch, trade size or

(ii) twenty-five vent pipes of 1-1/4 inch, trade size.

(4) A brach vent, vent stack or stack vent of 2-1/2 inch, trade size, shall have connected to it not more than ten water-closet vent pipes of 1-1/2 inch, trade size, and

(a) twelve other vent pipes of 1-1/2 inch, trade size; or

(b) twenty-five vent pipes of 1-1/4 inch, trade size.

(5) The waste pipe from a fixture and having a diameter of not more than 1-1/4 inches may be connected to a circuit vent, loop vent, relief vent or yoke vent or to the point of connection between the main vent and the building drain, soil stack or waste stack if the fixture is on the same floor level as any other fixtures being vented by the vent and if the fixture complies with sections 101 to 103.

MAXIMUM LENGTH OF VENTS

Column 1	Column 2
Pipe, trade size, length, in inches	Maximum in feet
1-1/4	50
1-1/2	50
2	60
2-1/2	80
3	100
4	150
5	200
6	250

STANDARD TRADE SIZES AND CROSS-SECTIONAL AREAS OF VENT PIPES

Column 1	Column 2
Pipe, standard trade size, in inches	Cross-sectional area, in square inches
1-1/4	1.2272
1-1/2	1.7671
2	3.1416
2-1/2	4.9089
3	7.0686
4	12.5664
5	19.6350
6	28.2743
7	38.4845
8	50.2655
9	63.6173
10	78.5398

SIZE OF PIPING FOR TRAP VENTS

Column 1	Column 2
Trap, trade size, in inches	Vent-pipe, trade size, in inches
1-1/4	1-1/4
1-1/2	1-1/4
2	1-1/2
2-1/2	1-1/2
3	1-1/2
4	1-1/2
5	2
6	2
over 6	3

Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
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TO O.B.C. CODE 1990

7.6.4. Water Efficiency

7.6.4.1.(1) The flow rates of fittings that supply water to a *fixture* shall not exceed the maximum flow rates at the test pressures listed for that fitting in Table 7.6.4.A.

Table 7.6.4.A.
Forming Part of Sentence 7.6.4.1.(1)

Maximum Flow Rated for Water Supply Fittings		
Fitting	Maximum Flow L/min (gal/min)	Test Pressure, kPa (psi)
Lavatory Faucet	8.35 (1.84)	413 (59.9)
Kitchen Faucet	8.35 (1.84)	413 (59.9)
Shower Heads	9.50* (2.09)	550 (79.8)
Column 1	2	3

Notes to Table 7.6.4.A.:
* Shower heads producing a flow rate below 8 L/min (1.76 gal/min) may be individually regulated by pressure of thermostatic compensating valves.

(2) Sentence (1) does not apply to a *fixture* located in a *heritage building.*

(3) Notwithstanding Article 7.2.9.6., *plumbing* supply fittings and trim for lavatory faucets, residential kitchen faucets and shower heads shall be certified to CAN/CSA-B125, "Plumbing Fittings", including all amendments, revisions and supplements effective to March 1992.

Table 7.6.4.C.
Forming Part of Sentence 7.6.4.2.(4)

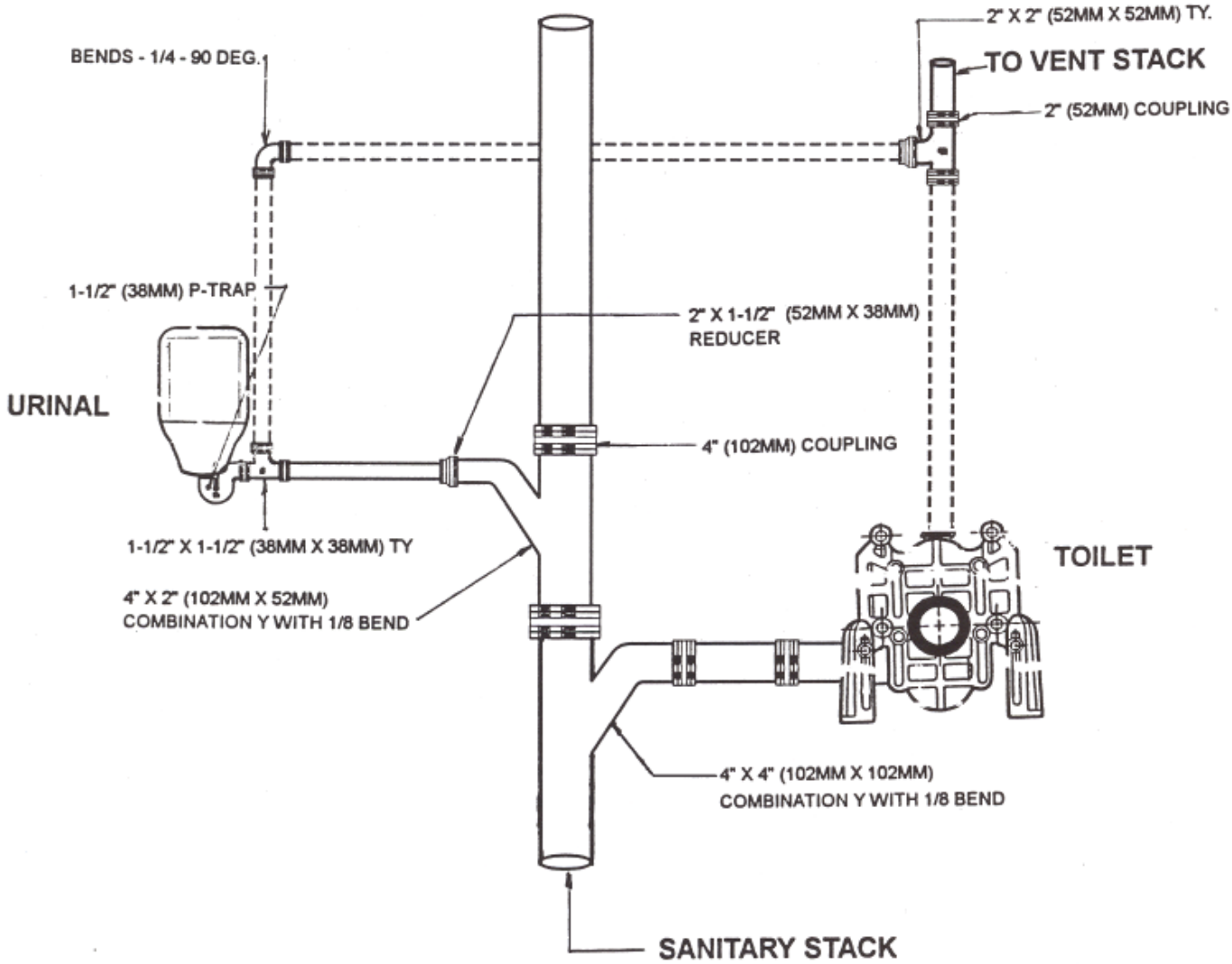
Maximum Flush Cycles for Sanitary Fixtures	
Fixture	litres (gal)
Water Closet (Tank Type)	6.0 (1.32)
Water Closet (Direct Flush)	6.0 (1.32)
Urinal (Tank Type)	3.8(1) (0.84)
Urinal (Direct Type)	3.8(1) (0.84)
Column 1	2

Notes to Table 7.6.4.C.:
(1) Urinals equipped with automatic flushing device shall be controlled to prevent unnecessary flush cycles during *building* down time.

7.6.3.3. Static Pressure. Where the static pressure exceeds 550 kPa (79.8 psi), a pressure reducing valve shall be installed to limit the maximum static pressure to not more than 550 kPa (79.8 psi) in areas that may be occupied.

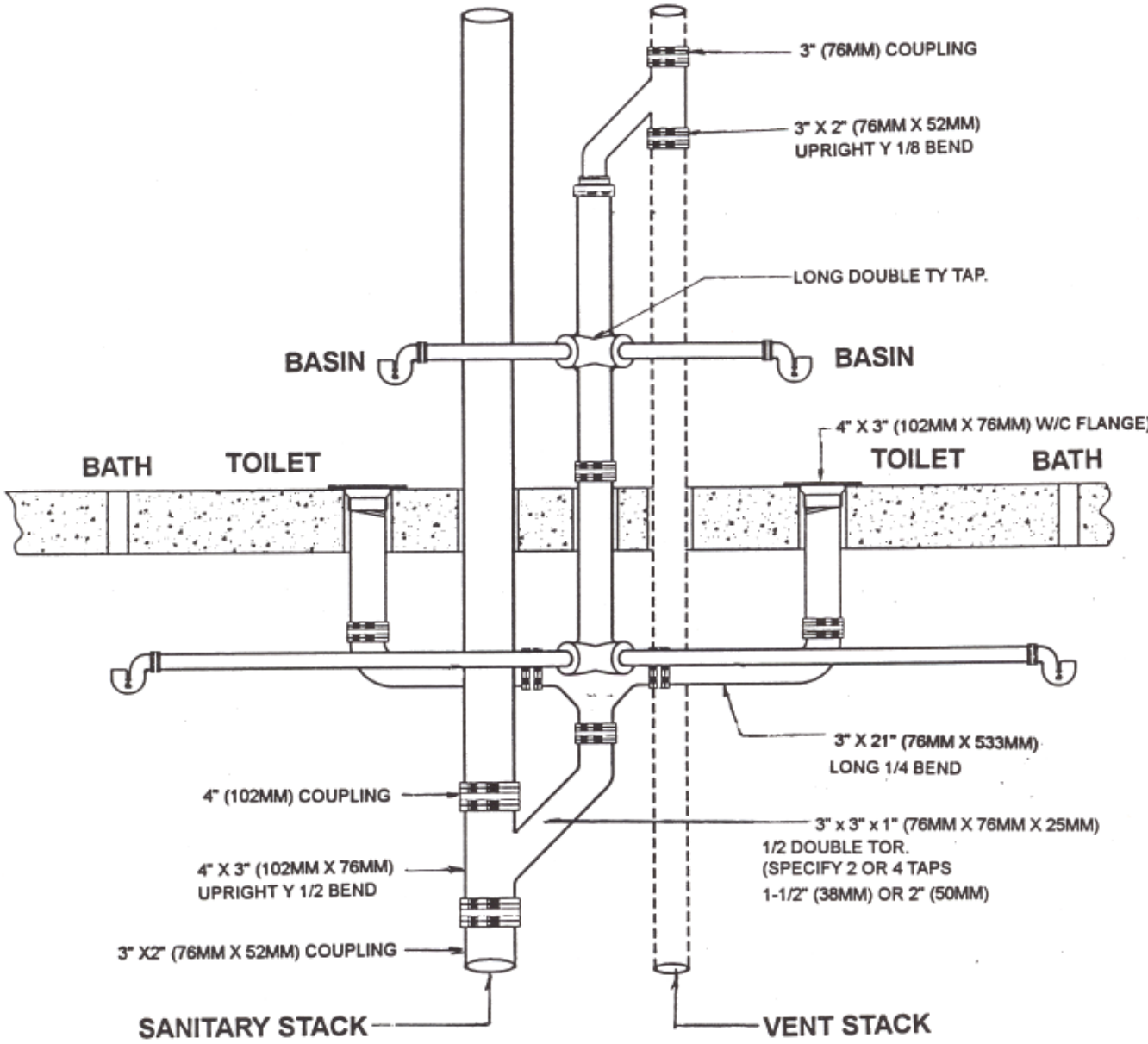
Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.

TOILET CARRIER \ URINAL C.I. STACK LAYOUT



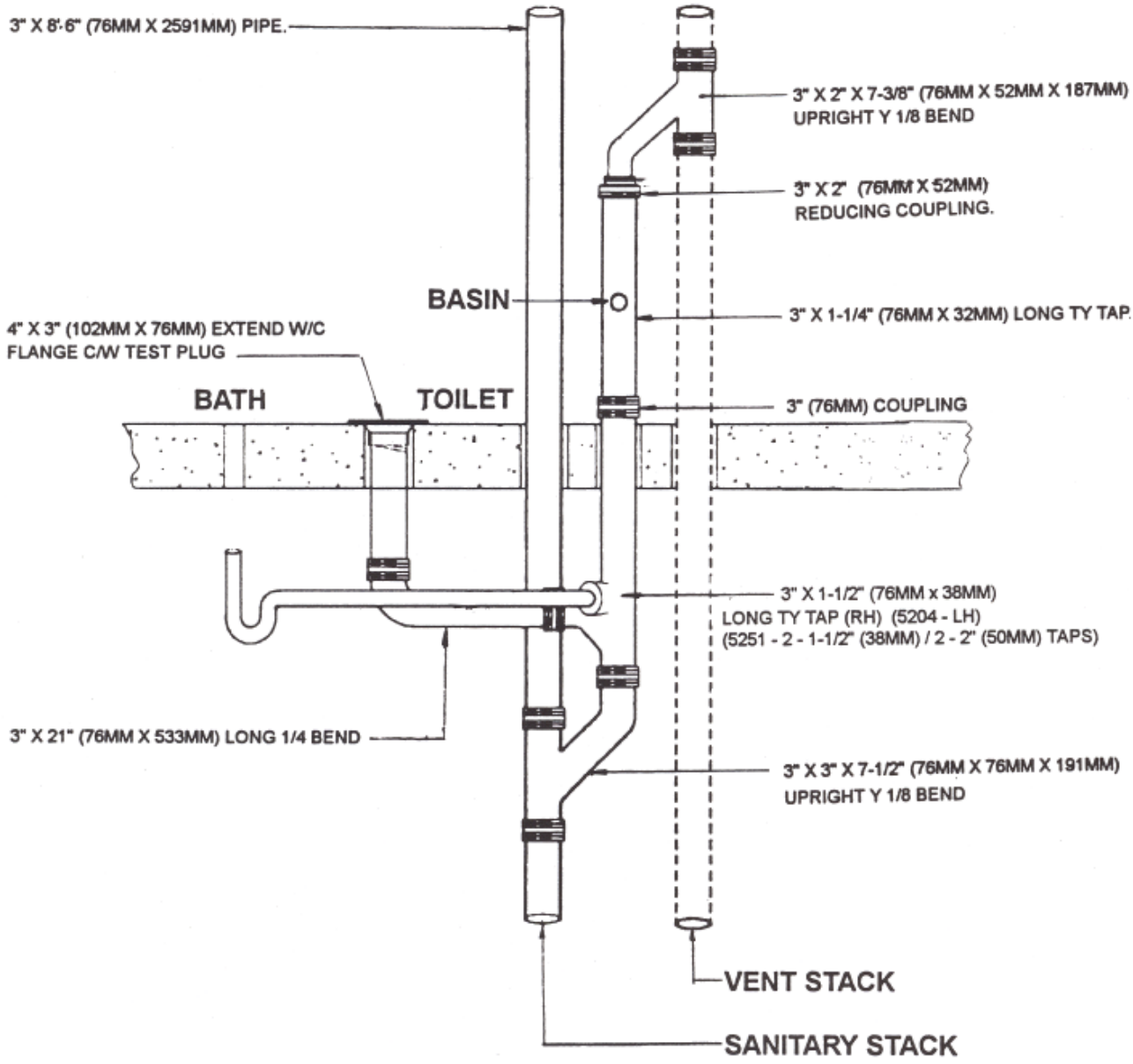
Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.

DOUBLE SUITE C.I. STACK LAYOUT
(MODIFIED STACK)



Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.

SINGLE SUITE C.I. STACK LAYOUT
(MODIFIED STACK)



Note: - Consult your local plumbing codes for sizing information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.

SMITH®

Flushing Rim Floor Drain

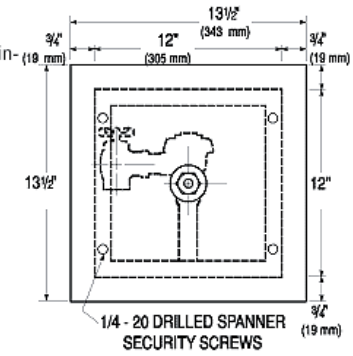
- [x] 2505TC
- [ ] 2506TC
- [ ] 2507TC

- [x] 195-1-XL
- [x] WB-1-A

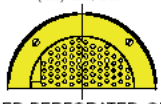
FLUSHING TYPE LABORATORY AND INSTITUTIONAL DRAINS

SLOAN

FUNCTION: Used in hospital operating rooms, cystoscopic and animal rooms where undesirable waste must be flushed to sewer. Particularly suitable for industrial and university laboratories. Used extensively in prisons, mental institutions and zoos as drain type water closets. Acid resistant coated interior and integral flushing rim maintain drain in sanitary condition.



Free Area 10 SQ IN (65) SQ CM

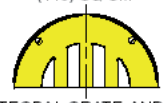


HINGED PERFORATED GRATE
Perforated hinged grate allows liquids but prevents solids from passing and allows easy access for cleaning interior.

Free Area 18 SQ IN (116) SQ CM

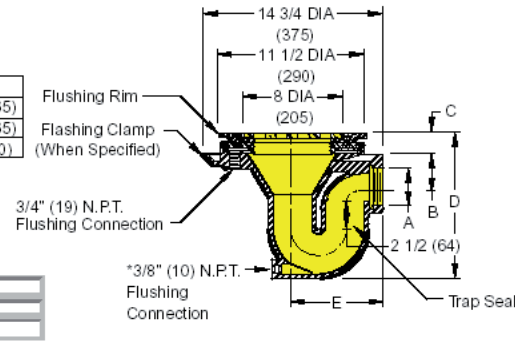
LOOSE SET WIDE BAR GRATE
Loose set wide bar grate permits solids disposal and allows removal for easy cleaning. Grate also available hinged (suffix-H).

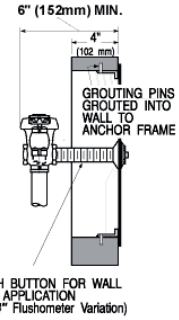
Free Area 17.5 SQ IN (113) SQ CM



INTEGRAL GRATE AND RIM
Vandal proof heavy wide bar grate permits solids disposal yet prevents removal of grate. Used where mentally disturbed or violent patients are confined.

A SIZE	B	C	D	E
02 (50)	3 5/8 (92)	1 3/4 (44)	13 3/8 (340)	10 1/2 (265)
03 (75)	3 1/8 (79)	1 3/4 (44)	13 3/8 (340)	10 1/2 (265)
04 (100)	2 15/16 (75)	1 3/4 (44)	13 3/8 (340)	9 1/2 (240)





TRAP DRAIN

HINGED PERFORATED GRATE . . . . Fig. 2505T
LOOSE SET WIDE BAR GRATE . . . . Fig. 2506T
INTEGRAL GRATE AND RIM . . . . . .Fig. 2507T

REGULARLY FURNISHED:
Duco Cast Iron Body and Flange with Acid Resistant Coated Interior and Nickel Bronze Top with Vandal Proof Screws.

NOTE: Dimensions shown in parentheses are in millimeters.

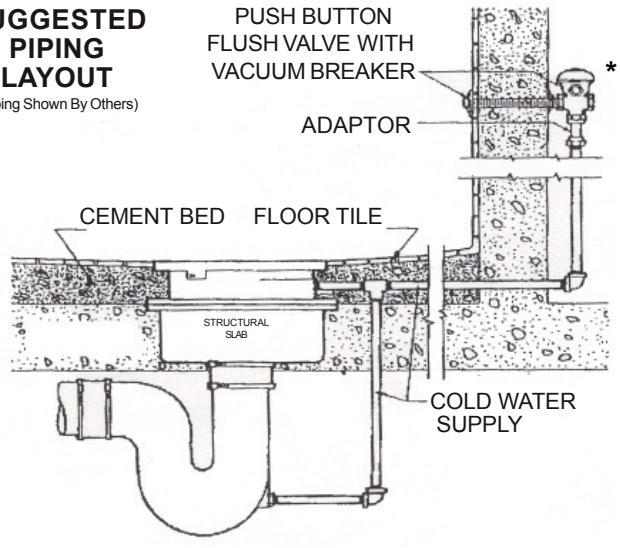
VARIATIONS:
- [X] Flashing Clamp -C
- [ ] Hinged Wide Bar Grate -H (Fig. 2501 & 2506 only)
- [ ] NO-HUB Adaptor (Specify Fig. 2646Y)
- [ ] Fabricated Stainless Steel Perforated Bucket -SSB
- [X] T Threaded Outlet

OPTIONAL MATERIALS:
- [ ] Polished Bronze Top -PB

*NOTE: The potable water supply to which a flushing type of drain is connected must be protected by a suitable vacuum breaker.

- [x] **WB-1-A** ACCESS PANEL, 12" (305mm) Square with 13-1/2" (343mm) Sqare stainless steel V.P. cover. (Space required - minimum 6" (152mm) finished wall to back of pipe space.)

SUGGESTED PIPING LAYOUT
(Piping Shown By Others)



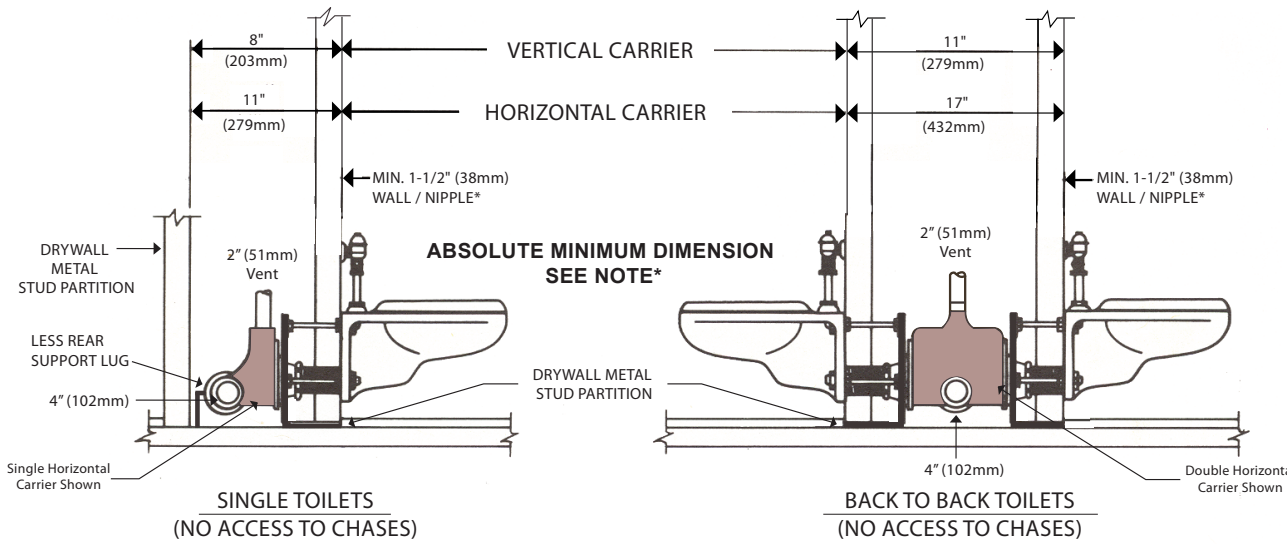
* CHECK LOCAL CODES FOR USAGE OF FLUSH VALVE AND VACUUM BREAKER

SLOAN

- [x] **195-1-XL 'REGAL'** CONCEALED DIAPHRAGM TYPE FLUSH VALVE, NON-HOLD OPEN FEATURE, BACK-CHECK ANGLE STOP, V.P. TRIM, VACUUM BREAKER, ADA OSCILLATING LEVER HANDLE, **6LPF** LOW CONSUMPTION.
- [ ] **195-1 'ROYAL'** As above except with Dual Filtered By-Pass, Permex Diaphragm, Diaphragm Type Handle, High Pressure V.B. (No Alternate Acceptable.)
- [ ] **195-1-L** (**'REGAL XL'** or **' ROYAL'**) As above except with **Push Button,** 5/8" (16mm) Diameter.

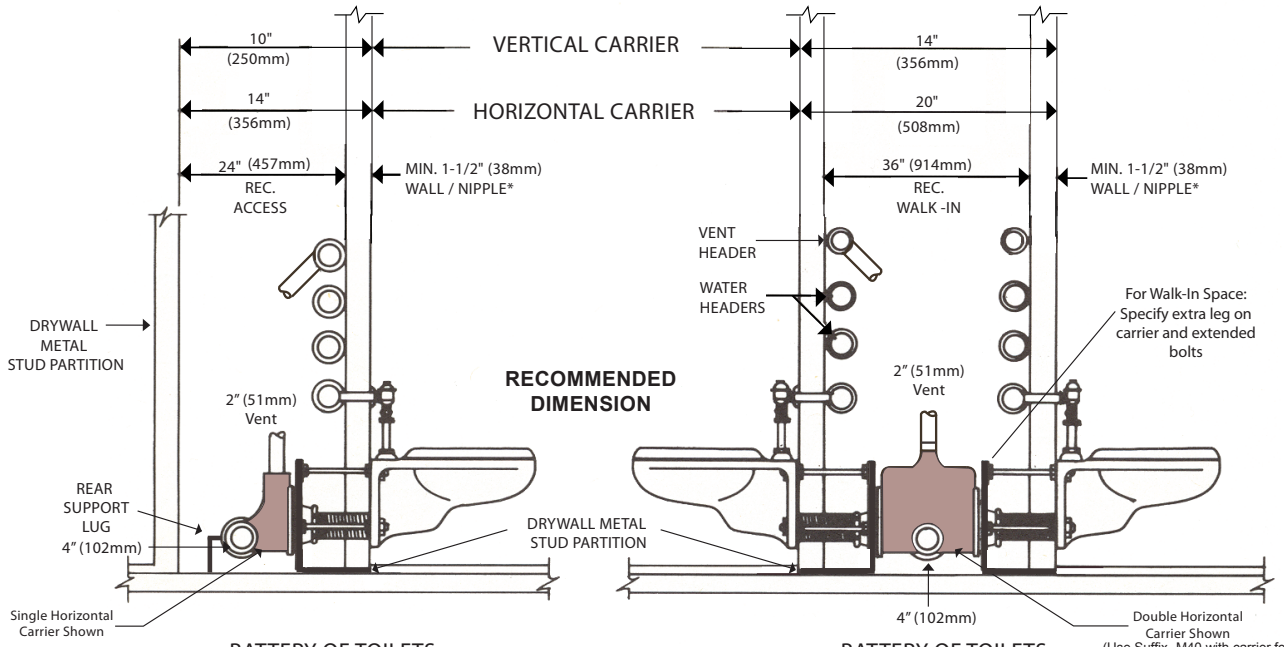
Note:
-Consult your local plumbing codes for sizing information
- In the absence of other guidance, the above date is provided
* ats is not responsible for content or accuracy of charts provided

PIPE CHASE CLEARANCES FOR WALL HUNG CARRIER TOILETS



SINGLE TOILETS
(NO ACCESS TO CHASES)

BACK TO BACK TOILETS
(NO ACCESS TO CHASES)



BATTERY OF TOILETS
ONE SIDE OF CHASE
(ACCESS TO CHASES THROUGH ACCESS PANEL OR DOOR)
ALSO REFER TO DWG NOs. 20-5 TO 20-12

BATTERY OF TOILETS
BACK TO BACK
(ACCESS TO CHASES THROUGH ACCESS PANEL OR DOOR)
ALSO REFER TO DWG NOs. 20-5 TO 20-12

Single Vertical Carrier

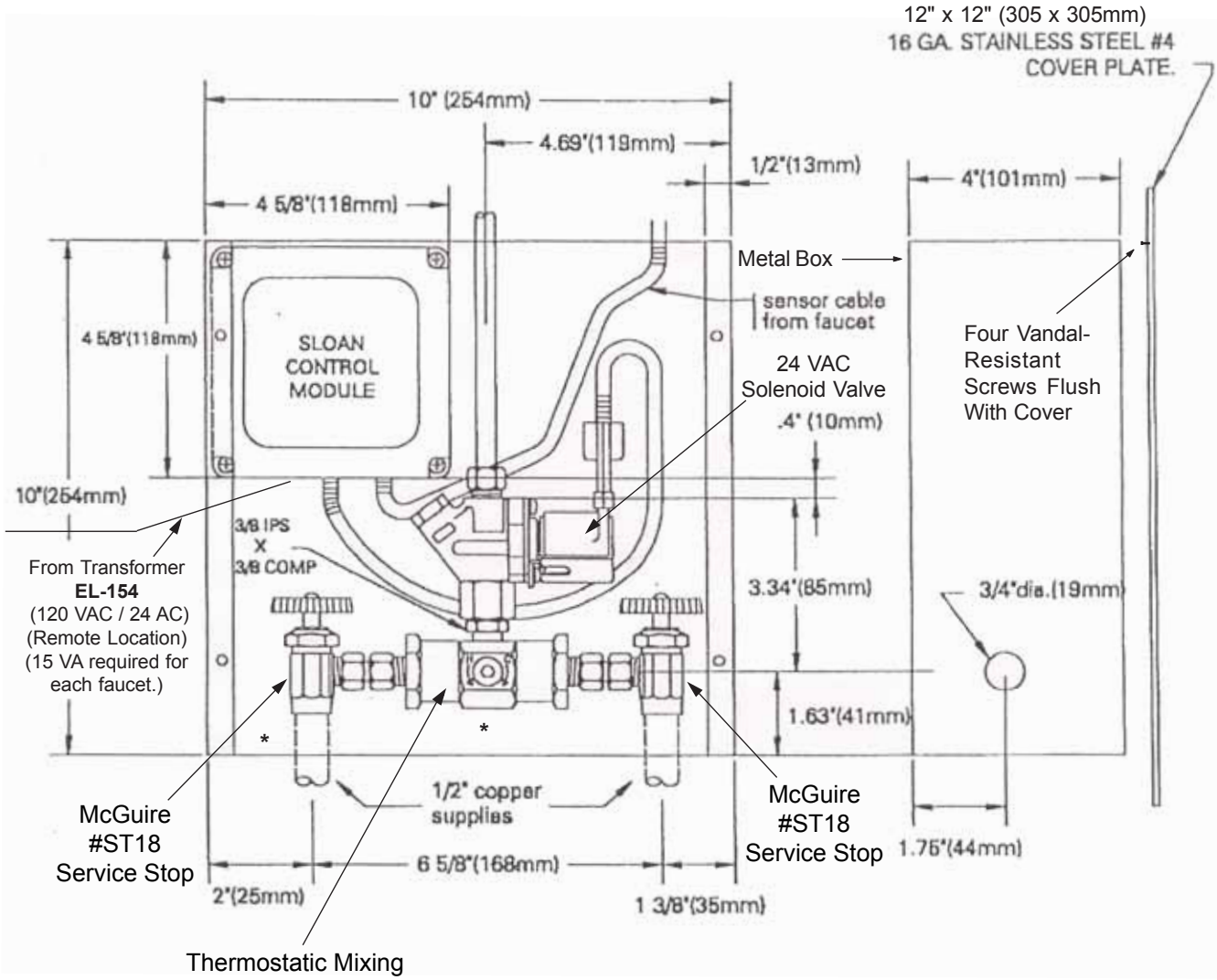
Double Vertical Carrier

NOTE:
* If clearances must be held to an **absolute minimum**, non-adjustable carrier to be used, less rear support lug and solid type walls may be cut, notched or chased to a minimum thickness of 1-1/2" (38mm) when this becomes necessary. Please note that extra labour will be required by the contractor to fit the carrier(s) within the wall or build the wall around the carrier(s) to meet these clearances. (Min. Length Bowl Nipple Coupling suffix **-M75** must also be specified).

Note: ats is not responsible for content or accuracy of charts provided

SLOAN

Vandal-Resistant Electronic 'No'Touch' Recessed Faucet Box
(Suffix 'VPB')



Note: ats is not responsible for content or accuracy of charts provided

LAWLER

Typical Installation

Install the mixing valve below the hot water tank or heater. If this is not possible, pipe in a heat trap as shown in Figure 1 with an approximate 27″ drop.

Connect a tempered water return line as shown in Figure 1. This allows flow through both ports of the mixing valve during periods of no draw.

If a dual temperature system is used, a separate recirculating loop and pump are required to return high temperature hot water to the water heater. See Figure 2.

Install an aquastat at the tempered water return pump.

Install the water heater per manufacturer's instructions.

Setting The Mixing Valve To The System

1. After installation be sure to flush the system thoroughly.
2. Make sure the hot water supply is heated to normal design temperature.
3. Close and tag all fixtures to ensure they are not used during this procedure.
4. Turn off the recirculating pump.
5. Create a draw on the system greater than the minimum flow rating of the mixing valve. All open fixtures must be tagged to ensure they are not tampered with or used during this procedure.
6. Allow water to flow through the mixing valve until the water temperature is stable. If necessary, readjust the mixing valve in accordance with the TEMPERATURE ADJUSTMENT section of the installation manual.
7. Once the temperature is set, start the recirculating pump and allow the system to reach set temperature.
8. Measure the water temperature at the return pump and adjust the aquastat to shut off the pump should the return water exceed the set point by 2 degrees F. Set the low limit switch to restart the return pump when return water drops 5 degrees F below the set temperature.
9. Set the balancing valve in the full open position.
10. Shut off all fixtures and ensure there is no draw on the system. The cold inlet to the mixing valve should be warm.
11. Allow the system to run in this condition for at least 30 minutes.
12. In some cases, an increase in water temperature may occur during a no draw period. If this occurs, slowly close the balancing valve until the water temperature is back to the original set temperature.

Note: ATS is not responsible for content or accuracy of charts provided

Figure 1

Typical Installation

When used in a single temperature recirculating system

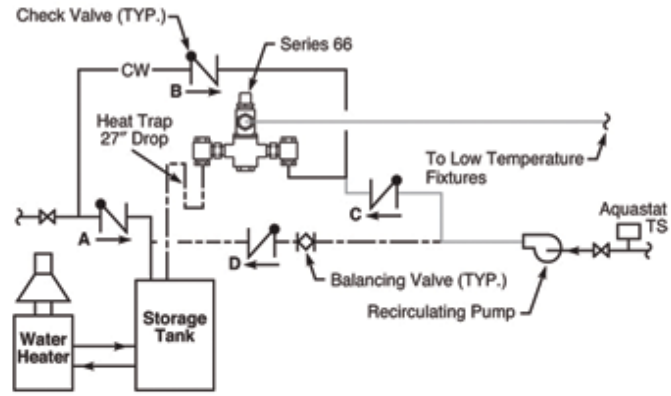
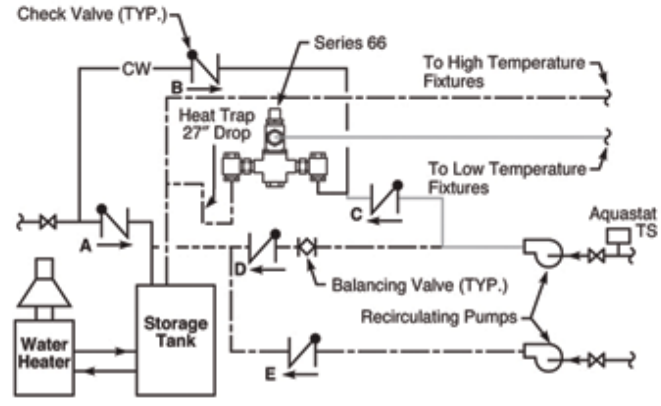


Figure 2

Typical Installation

When used in a dual temperature recirculating system



ACUDOR ACORN®

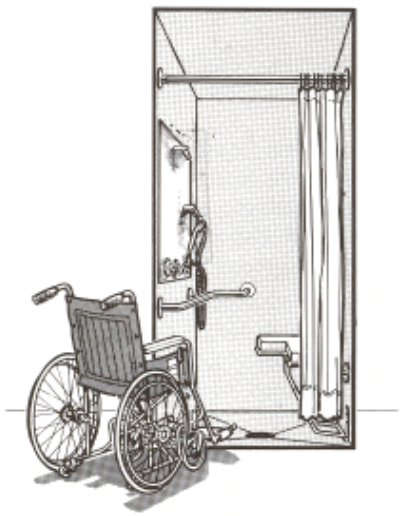
SUGGESTED BARRIER FREE SHOWER HEIGHTS

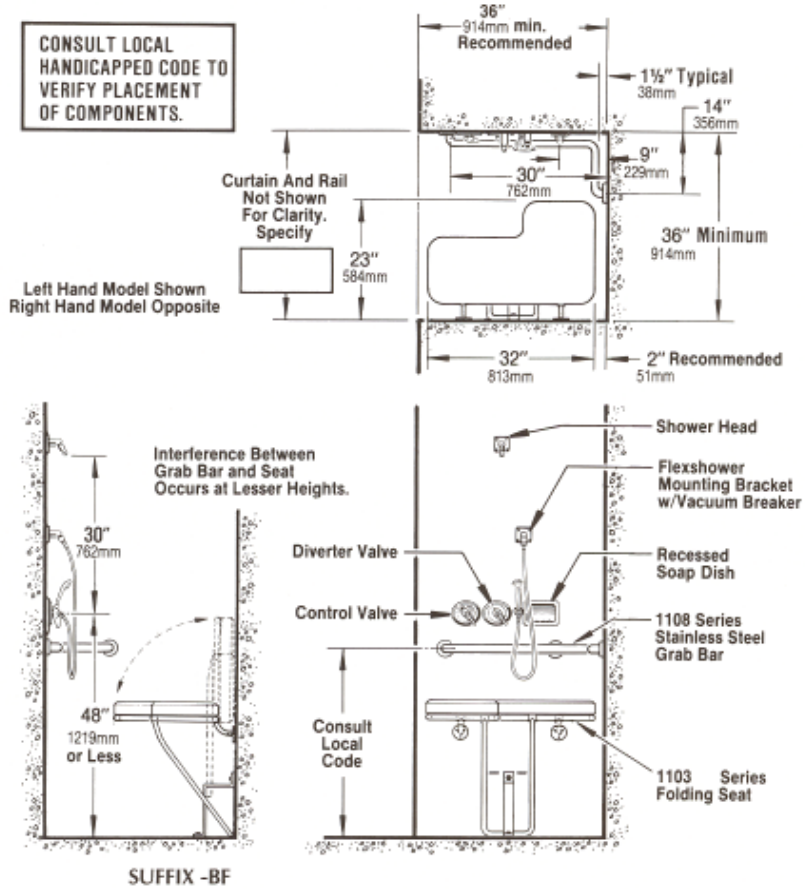
Zenith Built -In Handicapped Showers

- BF Barrier-Free Shower. This option includes a lever handle control valve, a flexshower with vacuum breaker, a lever handle diverter valve, a recessed soap dish, a padded vinyl folding seat, a two wall 1-1/2" diameter stainless steel grab bar and vinyl curtain with stainless steel 36" curtain rod.

- HC Handicapped Shower. This option includes a lever handle control valve, a flexshower with vacuum breaker, a lever handle diverter valve, a recessed soap dish, and a 24" x 1-1/2" stainless grab bar.

When either of these suffixes are specified, the housing is extended to accomodate the diverter valve, flexshower, and recessed soap dish.





SUFFIX -BF

Important: Installation instructions and current rough-in dimensions are furnished with each fixture. Do not rough-in without certified dimensions.

Note: ats is not responsible for content or accuracy of charts provided

SUGGESTED SHOWER MOUNTING HEIGHTS

Determining the Number of Stations Needed

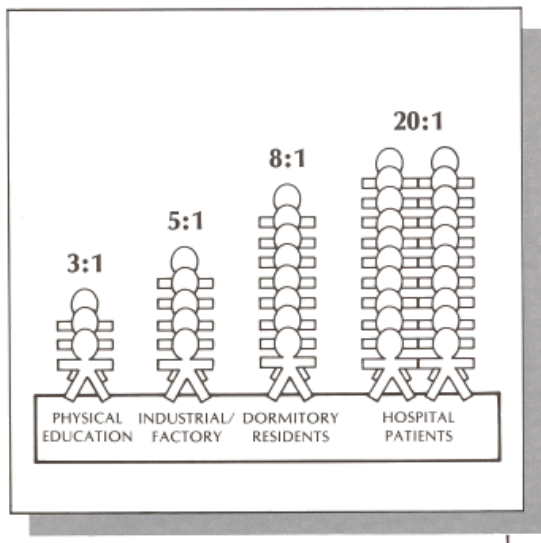
Ulimately, this number is based on cost constraints and available space considerations. The type of group using the showers and the anticiapted number of users during peak hours must also determined. School, industrial, athletic club, hospital, and dormitory settings all have differnent requirments.

Usually physical education classes have the highest useper shower within the specified time (often less than five minutes). A 3:1 (three students to one shower) ratio for schools is commonly allowed.

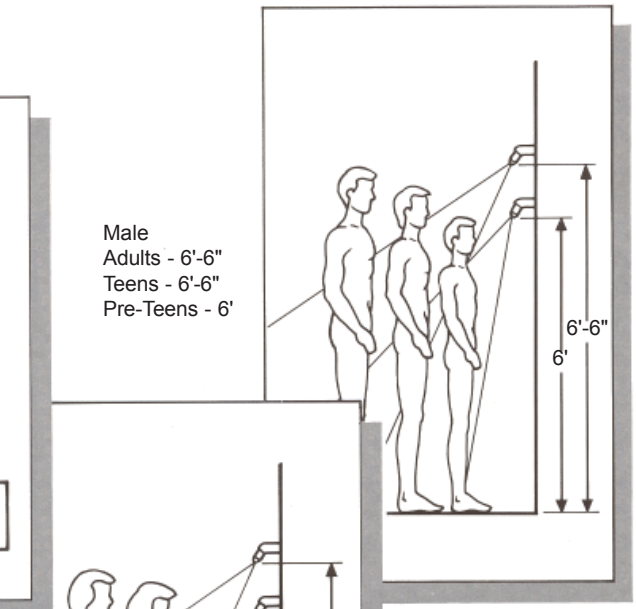
Bather Use

Shower rooms should be designed for the bather to use efficently with a minimum of wasted space. The bather's movements while showering, traffic flow to and from all the shower stations, and the bather's relationship to the shower spray - as well as to other bathers - must be considered.

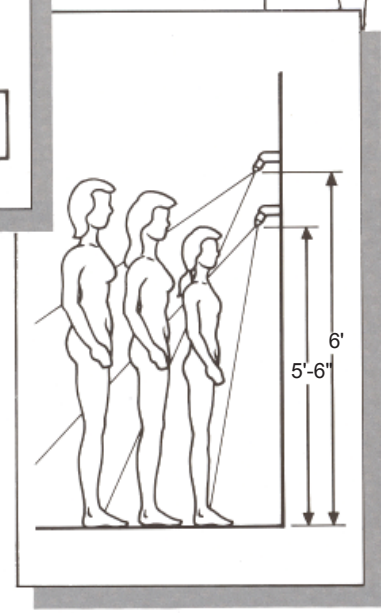
Operating upon the Premise that most bathers prefer to stand in such a manner that the head is normally out of direct water stream, the chart below indicates the average shower head mounting heights for various applications. These heights are generally standard, providing equal levels of comfort among users of every age category.



Industrial/factory workers utilize showers at a 5:1 ratio; dormitory resident usage is at an 8:1 ratio; and hospital patients can be factored at 20:1.



Male
Adults - 6'-6"
Teens - 6'-6"
Pre-Teens - 6'



Female
Adults - 6'
Teens - 6'
Pre-Teen - 5'-6"

Note: ats is not responsible for content or accuracy of charts provided

SUGGESTED MOUNTING HEIGHTS OF FIXTURES

Types of Fixtures	K & Jr. KG	K to 8 & Junior Public Schools	Senior Public Vocational Schools	Collegiate, Secondary Schools	Public Areas / Universities	Remarks
Drinking Fountains *	24" (610mm)	30" (762mm)	36" (914mm)	36" (914mm)	36" to 42" (914mm to 1066mm)	Floor to rim
Urinals **	----	18" (457mm)	20" (508mm)	24" (610mm)	24" (610mm)	Floor to rim
Basins	24" (610mm)	31" (787mm)	31" (787mm)	31" (787mm)	31" (787mm)	Floor to rim
Barrier Free Design Basins (To OBC/National)	33" (838mm)	33" (838mm)	33" (838mm)	33" (838mm)	33" (838mm)	Floor to rim
Toilets (For Wall Hung Toilets - Mount 15" (381mm) To Rim)	Std. or 10" Baby (254mm)	Std. 15" (381mm)	Std. 15" (381mm)	Std. 15" (381mm)	Std. 15" (381mm)	Floor to rim of bowl.
Barrier Free Design Toilets (To OBC/National)	16-1/2" (420mm)	16-1/2" (420mm)	16-1/2" (420mm)	16-1/2" (420mm)	16-1/2" (420mm)	Floor to rim of bowl.
(If additional height req. by local code or user - provide 2" (50mm) height seat and 16-1/2" (420mm) high Toilets)						
Shower Heads Boys Showers ***	----	----	5' (1524mm)	6' (1829mm)	6'-6" (1981mm)	Floor to Spray Head
Shower Heads Girls Showers ***	----	----	5' (1524mm)	5' - 6' (1524mm to 1829mm)	6' (1829mm)	Floor to Spray Head

*** Barrier Free Design showers provided with hand shower sprays and adjustable 30" (762mm) offset slide bar. Fold up seat, non slip floor and shower head wall hook next to seat.

** Barrier Free Design Urinals mounted 17" (432mm) OBC / 20" (508mm) BC - FIN. floor to rim.

* Barrier Free Design Drinking Fountains mounted 34" (863mm) FIN. floor to bubbler, single or Hi-Lo double units.

Note: - Consult your local plumbing codes for mounting height information.
- In the absence of other guidance, the above data is provided.
* ats is not responsible for content or accuracy of charts provided.