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A-6.1 PIPING FRICTION CHART 1:

A piping friction chart is used to choose an appropriate pipe size for designing a piping system. The chart provides many different pipe sizes, an appropriate GPM value for a pipe size, and a PD value in Ft Hd **per 100 feet** of a given pipe size. As a pipe size increases, its allowable GPM value increases in relation to a proper velocity factor. A high velocity factor, over 6 fps [feet per second] will cause noise in the piping and potential erosion. Some charts list different values for different piping materials due to the internal smoothness factors. Also, some charts list PD values in PSI and these values must be converted to Ft Hd values.

FLUID FLOW RATE GPM	TYPE L COPPER NOMINAL SIZE	TYPE L COPPER – PD PER 100 FEET	SCH 40 PVC NOMINAL SIZE	SCH 40 PVC – PD PER 100 FEET
GPM	INCHES	FT HD	INCHES	FT HD
1	½	2.40	½	0.5
2	½	8.04	½	2.43
4	¾	4.92	½	5.57
6	1	2.70	¾	3.01
8	1	4.50	1	1.58
10	1	6.70	1	2.63
12	1 ¼	3.38	1	3.77
14	1 ¼	4.48	1 ¼	1.50
16	1 ¼	5.65	1 ¼	1.7
18	1 ¼	7.02	1 ¼	2.0
20	1 ¼	8.43	1 ¼	2.45
22	1 ½	4.52	1 ¼	2.85
24	1 ½	5.30	1 ¼	3.35
26	1 ½	6.10	1 ¼	4.0
28	1 ½	6.97	1 ½	2.0
30	1 ½	7.58	1 ½	2.43
32	1 ½	8.92	1 ½	2.70
34	2	2.30	1 ½	3.06
36	2	2.55	1 ½	3.4
38	2	2.80	1 ½	3.7
40	2	3.36	1 ½	4.13
50	2	5.01	2	1.83
60	2	6.95	2	2.57
70	2	9.16	2	3.41
80	2 ½	4.12	2	4.37
90	2 ½	5.09	2 ½	2.29
100	2 ½	6.14	2 ½	2.78

Courtesy of Cooling Technologies, Inc. - Toledo, Ohio

A-6.1.2 PIPING FRICTION CHART 2:

FLOW	PRESSURE LOSS DUE TO FRICTION - PSI PER 100 FEET OF PIPE (TYPE L COPPER)						
GPM	3/8” Pipe	½” Pipe	5/8” Pipe	¾” Pipe	1” Pipe	1 ¼” Pipe	1 ½” Pipe
1	3.38	1.10	.422	.193	.045		
2	*11.5*	3.70	1.42	.652	.183	.068	
3	*23.2*	*7.53*	2.90	1.33	.374	.137	.060
4	*38.5*	*12.5*	4.81	2.20	.619	.228	.100
5		*18.4*	*7.11*	3.25	.915	.337	.147
6		*25.4*	*9.79*	4.48	1.26	.464	.203
7			*12.8*	*5.87*	1.65	.608	.266
8			*16.2*	*7.42*	2.09	.768	.336
9	2” Pipe	2½” Pipe	*19.9*	*9.13*	2.57	.944	.413
10	.133	.048		*11.0*	3.09	1.14	.497
12	.184	.066		*15.1*	4.25	1.56	.685
15	.272	.097		*22.4*	*6.29*	2.31	1.01
20	.450	.161	3” Pipe		*10.4*	3.83	1.68
25	.666	.238	.102		*15.4*	*5.67*	2.48
30	.917	.327	.140		*21.2*	*7.81*	3.42
35	1.20	.429	.184			*10.2*	4.48
40	1.52	.542	.233			*12.9*	*5.66*
50	2.25	.802	.344			*19.1*	*8.37*
60	3.09	1.10	.474				*11.5*
70	4.05	1.45	.621				*15.1*
80	5.12	1.83	.785				*19.1*
90	*6.30*	2.25	.965				
100	*7.58*	2.71	1.16				
125	*11.2*	4.00	1.72				
150	*15.4*	*5.51*	2.37				

This chart does not factor in a velocity factor. All figure entries which are in *Italics,* denotes values which may exceed 6 FPS (feet per second) and may cause a noise/erosion problem. Chart Courtesy of Arkla Industries, Inc.

A-6.1.3 PIPING FRICTION CHART 3: FRICTION LOSS (PER 100 FT) SCH 40 PVC PIPE

Velocity* = Speed of Water Flowing through a Pipe (Typically 6 FPS or less).

	3/4" PIPE			1" PIPE			1 1/4" PIPE			1 1/2" PIPE		
gpm	Vel	PSI	FtHd	Vel	PSI	FtHd	Vel	PSI	FtHd	Vel	PSI	FtHd
1	0.67	0.14	0.32									
2	1.34	0.51	1.17	0.81	0.04	0.09	0.46	0.04	0.09			
5	3.36	2.81	6.49	2.03	0.21	0.48	1.15	0.21	0.48	0.84	0.10	0.23
7	4.70	5.24	12.1	2.84	0.38	0.87	1.60	0.38	0.87	1.17	0.18	0.41
10	*6.71*	10.1	23.3	4.05	0.74	1.70	2.29	0.74	1.70	1.67	0.34	0.78
15	*10.1*	21.5	49.6	*6.08*	1.57	3.62	3.44	1.57	3.62	2.51	0.73	1.68
20				*8.11*	2.68	6.19	4.58	2.68	6.19	3.34	1.24	2.86
25				*10.1*	4.05	9.35	5.73	4.05	9.35	4.18	1.87	4.32
30				*12.2*	5.68	13.1	*6.88*	5.68	13.1	5.01	2.63	6.07
35							*8.02*	7.55	17.4	5.85	3.50	8.08
40							*9.17*	9.67	22.3	*6.68*	4.48	10.3
45							*10.3*	12.0	27.7	*7.52*	5.57	12.8
50							*11.5*	14.6	33.7	*8.35*	6.77	15.6
60										*10.0*	9.49	21.9

	2" PIPE			2 1/2" PIPE			3" PIPE			4" PIPE		
gpm	Vel	PSI	FtHd	Vel	PSI	FtHd	Vel	PSI	FtHd	Vel	PSI	FtHD
10	1.00	0.10	0.23									
15	1.50	0.21	0.48	1.05	0.09	0.20						
20	2.00	0.36	0.83	1.40	0.15	0.34						
25	2.50	0.54	1.24	1.75	0.23	0.53						
30	3.00	0.75	1.73	2.10	0.32	0.73						
35	3.50	1.00	2.31	2.45	0.42	0.97	1.58	0.15	0.34			
40	4.00	1.29	2.97	2.80	0.54	1.24	1.81	0.19	0.43			
45	4.50	1.60	3.69	3.15	0.67	1.54	2.03	0.23	0.53			
50	5.00	1.94	4.48	3.50	0.82	1.89	2.26	0.28	0.64			
60	*6.00*	2.73	6.30	4.21	1.15	2.65	2.71	0.39	0.90	1.56	0.10	0.23
70	*7.00*	3.63	8.38	4.91	1.53	3.53	3.16	0.52	1.20	1.82	0.14	0.32
80	*8.00*	4.64	10.7	5.61	1.96	4.52	3.61	0.67	1.54	2.08	0.18	0.41
90	*9.00*	5.78	13.3	*6.31*	2.43	5.61	4.06	0.83	1.91	2.34	0.22	0.50
100	*10.0*	7.02	16.2	*7.01*	2.96	6.83	4.51	1.01	2.33	2.60	0.27	0.62
125				*8.76*	4.47	10.3	5.64	1.53	3.53	3.25	0.40	0.92
150							*6.77*	2.15	4.96	3.91	0.56	1.29
175							*7.90*	2.86	6.60	4.56	0.75	1.73
200							*9.03*	3.66	8.45	5.21	0.96	2.21
250							*11.3*	5.53	12.7	*6.51*	1.45	3.34
300										*7.81*	2.03	4.68
350										*9.11*	2.70	6.23
400										*10.4*	3.46	7.99

(*) This Chart shows many entries for reference purposes only. Each Velocity column (Vel) has several entries which exceed 6 FPS (in *Italics*) and this factor may create water flow noise in piping and/or erosion.

Chart Courtesy of; **Lasco**® *Fittings, Inc.*

A-6.1.3-2 PIPING FRICTION CHART 3: CONTINUED

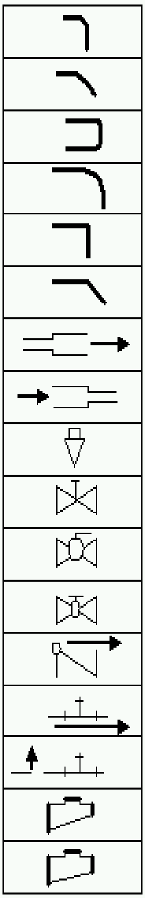
Friction Losses are Per 100 Feet of a given pipe size.

5" PIPE				6" PIPE			8" PIPE		
gpm	Vel*	PSI	FtHd	Vel	PSI	FtHd	Vel	PSI	FtHd
125	2.07	0.13	0.30						
150	2.48	0.19	0.43	1.71	0.08	0.18			
175	2.90	0.25	0.57	2.00	0.10	0.23			
200	3.31	0.32	0.73	2.28	0.13	0.30			
250	4.14	0.48	1.10	2.85	0.19	0.43	1.64	0.05	0.11
300	4.96	0.67	1.54	3.42	0.27	0.62	1.97	0.07	0.16
350	5.79	0.90	2.07	3.99	0.36	0.83	2.30	0.09	0.20
400	*6.62*	1.15	2.65	4.56	0.46	1.06	2.63	0.12	0.27
450	*7.45*	1.43	3.30	5.13	0.58	1.33	2.95	0.15	0.34
500	*8.27*	1.74	4.01	5.70	0.70	1.61	3.28	0.18	0.41
600	*9.93*	2.43	5.61	*6.84*	0.98	2.26	3.94	0.26	0.60
700	*11.6*	3.24	7.48	*7.98*	1.31	3.02	4.60	0.34	0.78

(*) This Chart shows many entries for reference purposes only. Each Velocity column (Vel) has several entries which exceed 6 FPS (in *Italics*) and this factor may create water flow noise in piping and/or erosion.
Chart Courtesy of; **Lasco**® *Fittings, Inc.*

A-6.2 CONVERSION CHART: a.k.a. Equivalent Length of Pipe Chart:

RESISTANCE OF VALVES AND FITTINGS IN EQUIVALENT FEET OF STRAIGHT PIPE
(*) ALL VALVES FIGURED AS FULLY OPEN, BALL VALVES =
APPROXIMATELY 50 % LESS THAN A GATE VALVE FULL OPEN



EQUIVALENT FEET CHART		NOMINAL PIPE SIZE IN INCHES						
Symbols	Valve/Fitting	3/4”	1”	1 ¼”	1 ½”	2”	2 ½”	3”
	90° Elbow	2.5	3.0	4.0	5.0	7.0	8.0	10.0
	45° Elbow	1.5	1.8	2.4	3.0	4.0	5.0	6.0
	180° Elbow	3.2	4.1	5.6	6.3	8.2	10	12
	Long Radius	1.4	1.7	2.3	2.6	3.3	4.1	5.0
	Miter Elbow	4.0	5.0	7.0	8.0	10.0	12.0	15.0
	Miter 45 Ell	.9	1.0	1.5	1.8	2.3	2.8	3.2
	Sudden Increase	1.5	2.0	3.0	3.6	4.8	6.1	8.0
	Sudden Decrease	1.0	1.2	1.8	2.2	3.0	3.8	4.9
	Plug Cock	1.3	1.6	2.1	2.5	3.2	3.8	4.8
	Gate Valve*	.5	.6	.8	1.0	1.3	1.6	2.0
	Ball Valve*	.25	.3	.4	.5	.65	.8	1.0
	Globe Valve*	20.0	25.0	35.0	45.0	55.0	65.0	80.0
	Check Valve	8.0	10.0	14.0	16.1	20.0	25.0	30.0
	Tee Thru	.8	.9	1.2	1.5	2.0	2.5	3.0
	Tee Side Out	4.0	5.0	6.0	7.0	10.0	12.0	15.0
	Tee ½ Reduced	2.0	2.6	3.4	4.0	5.0	6.0	7.5
	Tee ¼ Reduced	1.9	2.3	3.1	3.7	4.7	5.6	7.0

Once an appropriate pipe size has been chosen for designing the piping system, a total piping layout must be made including all piping required items (tees, 90 ells, 45 ells, valves, unions, couplers, reducers, etc.). First, the total length of all straight pipe is calculated. Then, ALL required piping items must be converted to an equal length of straight pipe using the above chart. These two values are then added together to obtain the grand total length of straight pipe. Then, referring to an appropriate friction chart, find the friction loss value for that pipe size and multiply that friction loss value by the length of pipe value to obtain the friction loss value for the designed system. This may be for one entire system having the same pipe size, or it may be for a separate circuit of a system having the same pipe size. All separate circuits must then be added for a total system value (normally in Ft Hd).

The data in the above chart, may be applied to a liquid or a gas.

Chart Courtesy of: Cooling Technologies, Inc. - Toledo, Ohio.

A-6.3 Antifreeze Correction Table: AND MORE

When antifreeze is added to the water system, and based upon the percentage added, two (2) important operating characteristics are created; 1- the viscosity of the fluid is increased which may require a larger horsepower pump motor, and 2- the total capacity of the chiller is reduced. The following charts may be used to reference these operating factors. These charts are based on ethylene glycol and may be used to size a water pump, or to verify a system's PD calculation which may be affected by an increased fluid viscosity factor.

Antifreeze Correction Chart		**Antifreeze Capacity Loss Chart**		
Antifreeze %	PD Sizing Multiplier	Outdoor Temp F Freezing Point	E. Glycol % By Volume	Capacity Loss By %
0 %	1.00	**25° F**	**10 %**	Negligible
10 %	1.03	**15° F**	**20 %**	**4 %**
20 %	1.06	**5° F**	**30 %**	**7 %**
30 %	1.12	**0°**	**33 %**	**9 %**
40 %	1.19	**- 5° F**	**35 %**	**10 %**
		- 10° F	**40 %**	**12 %**
Courtesy of;	Cooling Technologies	**- 20° F**	**45 %**	**16 %**

When calculating a designed system's PD, based on a manufacturer's supplied water pump and when choosing an appropriate pipe size based on the manufacturer's available external Ft Hd, do not forget to factor in the antifreeze correction multiplier. Your calculated PD may be ok for pure water, but not for the added antifreeze. This could mean a larger pipe size, a booster pump, or purchasing a separate external pump.

Fluid Volume Charts:

When antifreeze addition is required, the total fluid volume of a system must be calculated to determine the correct antifreeze volume (based on % desired).

Major System Components				**Water Piping (Gal. / Lineal Foot)**		
Equipment	Equip. Size	Approx. Volume Gal		Nominal Pipe Size Inches ID	Type L Copper	Other Piping
Chiller O/C*	5 Ton	5.0 / 2.0		1/2"	.0121	.0159
Water Coil	1 Ton	0.5		3/4"	.0251	.0279
Water Coil	2 Ton	0.8		1"	.0429	.0453
Water Coil	3 Ton	1.0		1 1/2"	.0924	.1066
Water Coil	4 Ton	1.5		2"	.1647	.1757
Water Coil	5 Ton	2.0		2 1/2"	.2479	.2507
Water Coil	7.5 Ton	3.0		3"	.3539	.3841
Water Coil	10 Ton	4.0				

(*) O = Open Chiller, C = Closed Loop Chiller. Courtesy of; Arkla & Cooling Technologies.
All figures are approximate, based on typical A-Coils. Always consult equipment manufacturer.

A-6.4 Other Useful Charts: CAPACITY CHARTS, COOLING & HEATING

Typical Cooling Coil Capacity Chart: 5 Ton A-Coil @ 2000 CFM.

Ent Wtr Temp° F	GPM	PD FtHd	Total MBH	
42	9.6	4.0	63.0	Note that as the entering water temperature drops, the total capacity increases for equal GPM values. Typical design conditions are; 45° F water @ 95° F ambient. Typical 5 Ton Chiller @ **12.0 GPM**
42	12.0	6.1	68.0	
42	14.4	8.7	72.0	
45	9.6	4.0	57.0	
45	**12.0**	**6.1**	**61.5**	
45	14.4	8.7	65.0	

Hot Water Heating: 2 Row Coil verses a 4 Row Coil

Chilled water cooling systems are applied by using a 4 row water coil. Most chilled water systems do not normally use an added 3 row heating only coil. The cooling coil is used for heating too. All water coils deliver heating and cooling based on an entering water temperature. 4 row coils, by design, do not require the same entering hot water temperature as do 2 row coils, to perform properly. The entering hot water temperature for a 4 row coil may be reduced considerably and can still provide proper heating. By referring to a manufacturer's capacity charts, it is possible to determine an appropriate entering hot water temperature for any applied 4 row or 2 row coil. By keeping the temperature as low as possible, and ensuring that proper heating is accomplished, extra savings will be seen for the system's total operating cost. The next two charts, show a comparison between a 4 row and 2 row coil when being applied for heating. Be sure to compare identical temperature and gpm entries per chart.

Typical Heating Capacity Chart: 5 Ton, 4 Row Coil @ 2000 CFM				**Typical Heating Capacity Chart:** 2 Row Heating Only Coil @ 2000 CFM			
Ent Wtr Temp ° F	GPM	PD FtHd	Total MBH	Ent Wtr Temp ° F	GPM	PD FtHd	Total MBH
120	9.6	3.33	85.0	120	6.0	0.43	54.0
120	12.0	5.21	88.0	120	12.0	1.81	62.0
120	14.4	7.50	90.0	120	18.0	4.48	65.0
150	9.6	33.3	129.0	150	6.0	0.43	81.0
150	**12.0**	**5.21**	**133.0**	150	12.0	1.81	91.0
150	14.4	7.50	135.0	150	18.0	4.48	97.0
180	9.6	3.33	172.0	180	6.0	0.43	109.0
180	12.0	5.21	177.0	**180**	**12.0**	**1.81**	**123.0**
180	14.4	7.50	180.0	180	18.0	4.48	130.0

All Charts are Courtesy of; Magic Aire®.

Please note that a 2 row heating only coil having 180 degree entering water, will deliver 123,000 btuh of heating capacity. But, a 4 row coil can deliver the same heating capacity having an entering water temperature of 150 degrees (**bold entries**). The water temperature could most likely be reduced a little more (145 degrees). Tailoring entering water temp and delivered capacity equals savings. What else but a 100 % true hydronic system could offer so much?

A-6.5 ANTIFREEZE TYPES & THEIR USE:

Very Important to Remember, "All Antifreezes ARE NOT Created Equal !"

There are 3 major factors which one must consider when choosing an antifreeze to be used with any chilled water and/or hot water system; 1 - Antifreeze Type (Ethylene Glycol based, or Propylene Glycol based), 2 - Inhibitors (A Good Inhibited product designed as a good heat transfer fluid for HVAC systems), 3 - Purity (Beware of the water you choose, it may be in your best interest to purchase a pre-mixed antifreeze product).

ANTIFREEZE PRODUCTS:

Over the years I have seen many systems with many types of antifreeze products being used, and many of these systems have been a mess. I had one large job which really needed a good cleaning and it needed new antifreeze. Not knowing a whole lot about antifreeze, I had to do a lot of home work on the subject and I finally made what I thought was a good choice. Fortunately, it was not only a good choice, it was a great choice. That same system, 15 years later, is still clean as new and most of the equipment still has the initial antifreeze in it which I put in. My choice was **DOWTHERM** * SR-1, manufactured by the Dow Chemical Company. Now I am not saying that there are no other appropriate antifreezes on the market, I have just learned over the years, never to argue with success. **DOWTHERM** is a good inhibited ethylene glycol based antifreeze, specifically developed as an HVAC heat transfer fluid. Dow Chemical also produces a propylene glycol based antifreeze called **DOWFROST**.* This product is also a good inhibited heat transfer fluid and it is typically used for environmentally sensitive applications (restaurants, hospitals and underground piping systems). Both of these products are available from Dow in pre-mixed percentages which use good clean distilled water. Many of the systems which had to be cleaned and replenished with new antifreeze, had been using automotive type antifreeze. While these antifreezes may be great for cars, they do not stand up well with the chiller systems, especially the Open Loop systems. Many systems required yearly additions of antifreeze to keep the freeze factor correct and some even allowed (created) a slime residue in the chiller's chiller tank. It is very highly advised to stay away from automotive antifreeze products.

FREEZE PROTECTION:

Every chiller system will require a minimum of 20% antifreeze by volume for general operational protection of the chiller and its evaporator cooling section. In geographical areas where the ambient temperatures can fall below freezing (32 degrees F) even more antifreeze will have to be added to protect the idle system from rupturing due to freezing. Antifreeze protection (% by volume) is basically established for one of two reasons; One for "Freeze Protection", or Two for "Burst Protection". **Freeze Protection**: This means that the fluid will always stay in a liquid form so that a water pump can easily circulate the fluid. This is a mandatory requirement for chiller-heater applications. **Burst Protection:** This means that the fluid may develop ice crystals, typically a water pump will not be able to circulate it, but it will not freeze solid enough to rupture any piping or component. This may typically be used for chiller only systems.

Because the addition of antifreeze causes a cooling capacity loss, it is never a good idea to use any larger percentage than a system really requires. Heating systems (chiller-heaters must be installed outdoors) must be freeze protected where applicable, but cooling only systems may be either freeze protected or burst protected. Protecting a cooling only system for burst protection makes the most sense due to the minimal capacity loss factor. The next page has a Freeze / Burst Protection Chart which the Dow Chemical Company has developed for their products; **DOWTHERM** SR-1 and **DOWFROST**. This chart outlines the volume percentages required for producing a proper fluid concentration for a given operational ambient temperature. No matter whose antifreeze product you choose to use, be sure it is specifically developed for HVAC Heat Transfer System. Be sure it is a Good Inhibited Product. Be sure to use a good quality water (alternately, Distilled Water or De-ionized Water) and purchase the antifreeze as a pre-mixed fluid if available. Good antifreeze products do pay for themselves by providing a good clean operating system which can last for years.

* **Trademark of The Dow Chemical Company**

A-6.5.2 DOW CHEMICAL PROTECTION CHART:

Concentrations of DOWTHERM SR-1 and DOWFROST fluids required to provide freeze protection and burst protection at various temperatures. "Used with permission of The Dow Chemical Company"

PROTECTION	PERCENT VOLUME OF GLYCOL CONCENTRATION REQUIRED			
CHART	FOR FREEZE PROTECTION		FOR BURST PROTECTION	
Temperature ° F	**Dowtherm** Ethylene Glycol	**Dowfrost** Propylene Glycol	**Dowtherm** Ethylene Glycol	**Dowfrost** Propylene Glycol
20	16.8 % †	18 %	11.5 % †	12 %
10	26.2 %	29 %	17.8 % †	20 %
0	34.6 %	36 %	23.1 % †	24 %
- 10	40.9 %	42 %	27.3 %	28 %
-20	46.1 %	46%	31.4 %	30 %
- 30	50.3 %	50 %	31.4 %	33 %
- 40	54.5 %	54 %	31.4 %	35 %
- 50	58.7 %	57 %	31.4 %	35 %
- 60	62.9 %	60 %	31.4 %	35 %

NOTE: These figures are examples only and may not be appropriate to your situation. Generally, for an extended margin of protection, you should select a temperature that is at least 5° F lower than the expected lowest ambient temperature. Inhibitor levels should be adjusted for solutions of less than 25-30% glycol. Contact Dow for information on specific cases or further assistance.
ATTENTION: These are typical numbers only and are not to be regarded as specifications. As use conditions are not within its control, Dow does not guarantee results from use of the information or products herein; and gives no warranty, express or implied.
† Inhibitor levels in glycol solutions less than 25-30% may not provide adequate corrosion protection. Solutions of glycol less than 25% may be at risk for bacterial contamination.
Courtesy of; The Dow Chemical Company - Midland, Michigan.

The Protection Chart shows the protection from freeze damage provided by various concentrations of **DOWTHERM** and **DOWFROST** glycol inhibited fluids. To determine the concentration required, select the lowest expected ambient temperature and decide whether the HVAC system requires **"Freeze Protection to keep the fluid Pumpable", or *"Burst Protection to simply prevent damage from fluid expansion".***

As a further measure of protection against dilution error, or unexpected cold temperatures, select a temperature that is at least 5° F colder than the lowest expected ambient temperature. If, for example, the lowest expected temperature is -15° F, select the line in the chart for -20° F. The chart shows that at this temperature, a solution of 46.1% **DOWTHERM** SR-1 is required for freeze protection. A concentration of 31.4% **DOWTHERM** SR-1 would be sufficient to provide burst protection at this temperature. If **DOWFROST** were being used, a 46% concentration would be required for freeze protection and 30% for burst protection. Care should be taken to avoid the use of excess glycol in order to minimize the impact on system efficiency.

Special Note:
Please note in part of the chart that propylene glycol requires a larger percentage by concentration than ethylene glycol does to provide an equivalent protection (freeze or burst). Propylene glycol has a little higher viscosity factor than ethylene glycol does and its use may require a higher horse power pump than ethylene glycol. The antifreeze correction chart (A 10.8) was for ethylene glycol and not for propylene glycol. When using either product (should you choose to follow my success), it may be best to contact Dow Chemical and request their Manual on these products. This manual covers all factors for using the products, including PD and calculation factors. Dow even has computer software for their products. If you use the Dow products and have any questions regarding the products inhibitors (break down in protection), a sample can be sent to Dow for a free analysis. Many times, a system may only require an inhibitor additive and not necessarily more fluid.

No Matter What Antifreeze Product You Choose, BE A SMART CONSUMER . Make sure that you have purchased a product which will serve you and your customer **B E S T !**

A-6.6 SYSTEM PD & PUMP SIZING CALCULATION FORM:

This form is intended to be an aid in completing a system's PD calculations. Depending upon a system's size and/or design, all information and data entry requirements may or may not be pertinent for every calculation. Also, for larger systems with multiple fluid pumps or a large intricate piping system, some data entry pages may have to be duplicated.

STEP 1: Listing Known Information & Data:

Project Name: ________________________________ Date: ________________.

Address: _____________________________ City: _______________ State: ________ Zip:___________.

System Capacity: (tons): _______ Chiller System: (number of or Model): ___________

Chiller(s) System's GPM Rating: _______ Load Zone(s) Total GPM: (if different): ___________

% Antifreeze: _______ PD of Chiller(s): ___________

Internal Pump (Y/N): _______ Ft Hd Available: ___________

External Pump (Y/N): _______ Single Pump System: ___________

Multiple Pump System: _______ Primary/Secondary Pump System: ___________

Total # Load Zones: _______ Primary / Secondary Zones: _____/_____

Zone 1: Tons _________ GPM Rating ________ PD Rating ________ PSI or __________ Ft Hd

Zone 2: Tons _________ GPM Rating ________ PD Rating ________ PSI or __________ Ft Hd

Zone 3: Tons _________ GPM Rating ________ PD Rating ________ PSI or __________ Ft Hd

Zone 4: Tons _________ GPM Rating ________ PD Rating ________ PSI or __________ Ft Hd

Zone 5: Tons _________ GPM Rating ________ PD Rating ________ PSI or __________ Ft Hd

Farthest Zone: __________ (duplicate page for more zones) **Ft Hd = PSI x 2.31**

STEP 2: Choose Pipe Material & Size(s): select appropriate pipe size from the Friction Chart

Piping Material: Schedule 40 PVC ___________ Copper ____________.

Pipe 1: Size _______ Inches. PD Rating ______ Ft Hd per 100 feet

Pipe 2: Size _______ Inches. PD Rating ______ Ft Hd per 100 feet

Pipe 3: Size _______ Inches. PD Rating ______ Ft Hd per 100 feet

Pipe 4: Size _______ Inches. PD Rating ______ Ft Hd per 100 feet

Pipe 5: Size _______ Inches. PD Rating ______ Ft Hd per 100 feet

STEP 3: Calculating Total Feet of Straight Pipe:

Pipe 1: Total Length _______ Ft (A) PD ________ (B) (A ÷ 100) x B = Total Ft Hd_____________.

Pipe 2: Total Length _______ Ft (A) PD ________ (B) (A ÷ 100) x B = Total Ft Hd_____________.

Pipe 3: Total Length _______ Ft (A) PD ________ (B) (A ÷ 100) x B = Total Ft Hd_____________.

Pipe 4: Total Length _______ Ft (A) PD ________ (B) (A ÷ 100) x B = Total Ft Hd_____________.

Pipe 5: Total Length _______ Ft (A) PD ________ (B) (A ÷ 100) x B = Total Ft Hd_____________.

Grand Total Straight Pipe Ft Hd (Pipe1 + Pipe2 + Pipe3 + Pipe4 + Pipe5):

_____________.

A-6.6.2 SYSTEM PD & PUMP SIZING CALCULATION FORM:

STEP 4: Equivalent Lengths of Piping System Items:

Use the system schematic and the Equivalent Length Conversion Chart to calculate an equivalent length of pipe and Ft Hd value for the system fittings and items. All pipe size reductions (sudden contraction, chiller's supply pipe to zone & coil inlet connection) and pipe size increases (sudden enlargement, zone's return pipe to chiller & coil outlet connection).

EPL = Equivalent Pipe Length.

Pipe 1: Size ______ Inches. PD value for this pipe size __________ Ft Hd / 100 Ft

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

Total EPL for all Pipe 1 Items: __________

Total PD (Ft Hd) for all Pipe 1 Items: Total EPL ________ ÷ 100 x Pipe1 PD ________ = ___________Ft Hd

Pipe 2: Size ______ Inches. PD value for this pipe size __________ Ft Hd / 100 Ft

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

Total EPL for all Pipe 2 Items: __________

Total PD (Ft Hd) for all Pipe 2 Items: Total EPL ________ ÷ 100 x Pipe1 PD ________ = ___________Ft Hd

Pipe 3: Size ______ Inches. PD value for this pipe size __________ Ft Hd / 100 Ft

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

A. Item Type ___________ B. Quantity _______ C. EPL _________ Ft B x C = Total EPL _______.

Total EPL for all Pipe 3 Items: __________

Total PD (Ft Hd) for all Pipe 3 Items: Total EPL ________ ÷ 100 x Pipe1 PD ________ = ___________Ft Hd

Note: Depending upon the designed system's size (different pipe sizes, quantity of items, etc.) this page may need to be duplicated or modified for one's particular needs. ***The important factor is, do not miss any items. Double check all.***

A-6.6.3 SYSTEM PD & PUMP SIZING CALCULATION FORM:

STEP 5: PD of 3-Way Valves:

The Cv rating of most valves are available from the manufacturer. Use 3-Way Valve from farthest zone.

3-Way Valve: Size __________ Inches Cv Rating _________ PD (psi) = (GPM ÷ Cv)^2 = _____________

PSI x 2.31 = _____________Total Ft Hd

STEP 6: Finalizing the System's Total Ft Hd Calculations:

Add up all the system PD's. Compare to the available head from a factory installed water pump, OR use the PD to size a to be purchased water pump.

1. Enter the PD value for the chiller(s) (if internal pump used, enter zero):		Ft Hd ______.__________
2. Enter the PD value of the farthest zone (Step 1):		Ft Hd ______.__________
3. Enter the PD value of the system's pipe: (Step 3 Grand Total):		Ft Hd ______.__________
4. Enter the PD value of the piping items (Step 4 - each pipe size):	Pipe 1	Ft Hd ______.__________
	Pipe 2	Ft Hd ______.
	Pipe 3	Ft Hd ______.__________
	Pipe 4	Ft Hd ______.__________
	Pipe 5	Ft Hd ______.__________
5. Enter the PD value of the 3-way valve (Step 5 - farthest zone):		Ft Hd ______.__________
6. Add up all PD entries for a Sub Total PD: .		Ft Hd ______.__________
7. Multiply By Antifreeze Correction Factor		**x** ______.__________
8. System PD Grand Total:		Ft Hd ______.__________
9. Round up to the nearest whole figure (special note):		Ft Hd ______.__________
10. Enter a PD safety value of 5.0 Ft Hd. (this is for separate pump sizing purposes):		+ ____5____
Grand Total System PD:		**Ft Hd ______.__________**

For Factory Installed Water Pump:

(1) If the Grand Total PD is less than the Available Head for the pump, system design is acceptable.
(2) If the Grand total PD is more than the Available Head for the pump, try a larger pipe size.
(3) If a larger pipe size is not feasible, either purchase a separate external pump, or use a booster pump.

For Purchasing a New External Water Pump:

(1) Use the Grand Total PD and the system flow rate (GPM) to size and order a pump. If the cost or horsepower is not acceptable, try using a larger pipe size to reduce the PD, or consider two pumps in either series or parallel.

Special Note: Always round calculated values up to the nearest whole number (no decimals) to stay conservative.