Bulletin 1400
Air-Cooled Condensers

DIRECT DRIVE REMOTE AIR-COOLED CONDENSERS

33 MODELS

5 to 135 Ton (62 through 1625 MBH)
Total Heat of Rejection @ 20F TD

Also available in ACH Models with Horizontal Discharge

"The Heat Transfer Experts"

TABLE OF CONTENTS

STANDARD FEATURES:

- Wide range of models and capacities - 33 models.
- Corrosion resistant construction - Mill galvanized housing, plated steel fan guards, aluminum (3/4 and 1 Hp) or galvanized steel (2 Hp) fan blades. Low speed, fully guarded fans for quiet operation.
- Built-in lifting eyes, and easy-to-install legs, make rigging and installation fast.
- Compartmented fans to prevent short circuiting of air during fan cycling.
- Units designed for efficient fan cycle control, and multi-circuiting.
- Versatile cabinet design for vertical or horizontal airflow.
- Condenser coil is made of 1/2" dia seamless copper tubes,and high efficiency aluminum plate-type fins, with selfspacing collars.
- Exclusive Colmac “Full Floating Core” coil support system eliminates tubesheet leaks by shifting support of the coil core from tubes to fins. Special “Wear Guards” allow expansion and contraction of fins and tubes without chafing or wearing of tubes, or fins.
- Heavy duty rigid foot-mounted direct drive fan motors with moisture protected rainshields (slingers) are internally protected single or three phase on models 62 thru 384 (3/4 Hp), internally protected three phase only on models 119 thru 1271 (1 Hp), and three phase externally protected only on models 1425 thru 1625 (2 Hp). Motors are rated for 150°F maximum air temperature over the motor.
- Weatherproof electrical enclosure features single point field wiring, and is easily accessible for fast installation.

OPTIONS:

- Copper fins, or special fin coatings for corrosion resistance.
- Stainless or galvanized steel fan blades.
- Stainless steel housing.
- Multiple circuits for multiple compressor systems.
- Subcooler coil for liquid subcooling.
- Factory mounted and piped liquid receiver.
- Factory mounted and wired fused disconnect.
- Factory wired low-ambient head pressure control.
- Customer specified control systems.

NOMENCLATURE:

AC V - 763 - D

AC
Air Cooled Condenser

V
V - Vertical Air Discharge
H - Horizontal Air Discharge

Unit capacity,
MBH @ 20F TD

VOLTAGE CHARACTERISTICS

A - 208-230/60/1
B - 208-230/60/3
C - 460/60/1
D - 460/60/3
E - 575/60/3
F - 380/50/3

TABLE 1
ACV/ACH AIR-COOLED CONDENSER RATED CAPACITIES

Model	Fan dia,in.	No. Fans	CFM	MBH @ 1° F TD ①	TON RATING @ 1° F TD ②	MBH @ 20° F TD	TON RATING @ 20° F TD ②
62	24	1	6310	3.098	.195	61.96	3.911
84	24	1	6039	4.183	.263	83.66	5.281
96	24	1	5734	4.794	.302	95.88	6.053
119	30	1	8620	5.948	.375	118.96	7.509
127	30	1	8090	6.357	.400	127.14	8.026
167	24	2	12078	8.366	.528	167.32	10.562
192	24	2	11468	9.588	.605	191.76	12.106
223	30	2	18060	11.156	.703	223.12	14.085
238	30	2	17240	11.896	.750	237.92	15.019
251	24	3	18117	12.549	.791	250.98	15.844
254	30	2	16180	12.714	.802	254.28	16.053
288	24	3	17202	14.382	.907	287.64	18.159
307	24	4	24800	15.324	.967	306.48	19.348
335	24	4	24156	16.732	1.056	334.64	21.125
357	30	3	25860	17.844	1.126	356.88	22.530
381	30	3	24270	19.071	1.203	381.42	24.079
384	24	4	22936	19.176	1.210	383.52	24.212
446	30	4	36120	22.312	1.408	446.24	28.171
476	30	4	34480	23.792	1.501	475.84	30.040
509	30	4	32360	25.428	1.605	508.56	32.106
595	30	5	43100	29.740	1.877	594.80	37.550
636	30	5	40450	31.785	2.000	635.70	40.132
714	30	6	51720	35.688	2.253	713.76	45.060
763	30	6	48540	38.142	2.407	762.84	48.159
893	30	8	72240	44.624	2.816	892.48	56.343
952	30	8	68960	47.584	3.003	951.68	60.080
1017	30	8	64720	50.856	3.210	1017.12	64.212
1116	30	10	90300	55.780	3.521	1115.60	70.428
1190	30	10	86200	59.480	3.754	1189.60	75.100
1271	30	10	80900	63.570	4.012	1271.40	80.265
1425	36	10	111900	71.237	4.496	1424.74	89.945
1502	36	10	101600	75.085	4.740	1501.70	94.803
1625	36	10	88000	81.241	5.128	1624.82	102.576

Based on performance with R-22, 0 F subcooling, 60 Hz supply power, elevation of 0 ft AMSL. (apply appropriate correction factors for change in performance due to increase in elevation, and 50 Hz operation).

NOTES:

1. For TD's other than 20°F, use the Factor in these tables times the desired TD.

2. Ton rating is the amount of system cooling capacity, in tons, based on R-22, 40°F suction temperature, and 120°F condensing temperature.

TABLE 2
ACV/ACH PHYSICAL SPECIFICATIONS

Model	Fan Dia. in.	No. Fans	Motor H.P.	Coil Face	Rows Deep	Fins/ Inch	Internal Vol. Cu/Ft.	Total Avail cts..	R22 Charge, lbs. Normal Opera.	R22 Charge, lbs. Flooded	Dry Wt. lbs.
62	24	1	3/4	35 x 48	2	14	0.324	4	5.5	22.0	330
84	24	1	3/4	35 x 48	3	14	0.487	6	8.3	33.1	357
96	24	1	3/4	35 x 48	4	14	0.649	4	11.0	44.1	383
167	24	2	3/4	35 x 96	3	14	0.936	7	15.9	63.6	589
192	24	2	3/4	35 x 96	4	14	1.25	8	21.3	84.9	643
251	24	3	3/4	35 x 144	3	14	1.39	14	23.6	94.4	863
288	24	3	3/4	35 x 144	4	14	1.85	14	31.5	125.6	944
307	24	4	3/4	35 x 192	3	11	1.84	14	31.3	124.9	1056
335	24	4	3/4	35 x 192	3	14	1.84	14	31.3	124.9	1096
384	24	4	3/4	35 x 192	4	14	2.45	28	41.7	166.4	1203
119	30	1	1	45 x 54	3	14	0.698	6	11.9	47.4	513
127	30	1	1	45 x 54	4	14	0.931	6	15.8	63.2	552
223	30	2	1	45 x 108	3	11	1.35	9	23.0	91.7	815
238	30	2	1	45 x 108	3	14	1.35	9	23.0	91.7	843
254	30	2	1	45 x 108	4	14	1.80	12	30.6	122.2	921
357	30	3	1	45 x 162	3	14	2.00	18	34.0	135.8	1242
381	30	3	1	45 x 162	4	14	2.66	18	45.2	180.6	1358
446	30	4	1	45 x 216	3	11	2.65	18	45.1	179.9	1516
476	30	4	1	45 x 216	3	14	2.65	18	45.1	179.9	1572
509	30	4	1	45 x 216	4	14	3.53	24	60.0	239.7	1728
595	30	5	1	45 x 270	3	14	3.30	27	56.1	224.1	1971
636	30	5	1	45 x 270	4	14	4.40	36	74.8	298.8	2165
714	30	6	1	90 x 162	3	14	4.00	36	68.0	271.6	2374
763	30	6	1	90 x 162	4	14	5.32	36	90.4	361.2	2607
893	30	8	1	90 x 216	3	11	5.30	36	90.1	359.9	2927
952	30	8	1	90 x 216	3	14	5.30	36	90.1	359.9	3040
1017	30	8	1	90 x 216	4	14	7.06	48	120.0	479.4	3351
1116	30	10	1	90 x 270	3	11	6.60	54	112.2	448.1	3661
1190	30	10	1	90 x 270	3	14	6.60	54	112.2	448.1	3803
1271	30	10	1	90 x 270	4	14	8.80	72	149.6	597.5	4191
1425	36	10	2	90 x 270	3	14	6.60	54	112.2	448.1	4368
1502	36	10	2	90 x 270	4	14	8.80	72	149.6	597.5	4756
1625	36	10	2	90 x 270	6	14	13.20	72	224.4	896.3	5532

Notes:

1. Refrigerant charge is calculated as follows:
   Flooded Charge(lbs) = Internal Vol. (cu. ft.) x Liquid Density(lbs/cu ft)

   Normal Oper. Charge(lbs) = Internal Vol. (cu. ft.) x .25 x Liquid Density(lbs/cu ft)

2. Operating Weight = Dry Weight + Refrigerant Charge

3. Units having finned length up to and including 216” use 1/2 x 0.016” copper tubes.
   Units having finned length of 270” use 1/2 x 0.025” copper tubes.

TABLE 3 ACV/ACH ELECTRICAL SPECIFICATIONS

Model	Fan dia,in.	No. Fan	Fan Hp	Total FLA/60 Hz Supply 208-230/1	208-230/3	460/1	460/3	Total FLA/50 Hz Supply 200/3	380/3
62	24	1	3/4	3.9	3.40	1.9	1.55	4.2	2.1
84	24	1	3/4	3.9	3.40	1.9	1.55	4.2	2.1
96	24	1	3/4	3.9	3.40	1.9	1.55	4.2	2.1
167	24	2	3/4	7.8	6.80	3.8	3.10	8.4	4.2
192	24	2	3/4	7.8	6.80	3.8	3.10	8.4	4.2
251	24	3	3/4	11.7	10.20	5.7	4.65	12.6	6.3
288	24	3	3/4	11.7	10.20	5.7	4.65	12.6	6.3
307	24	4	3/4	15.6	13.60	7.6	6.20	16.8	8.4
335	24	4	3/4	15.6	13.60	7.6	6.20	16.8	8.4
384	24	4	3/4	15.6	13.60	7.6	6.20	16.8	8.4
119	30	1	1	note 1	5.6	note 1	2.8	4.2	2.1
127	30	1	1	”	5.6	”	2.8	4.2	2.1
223	30	2	1	”	11.2	”	5.6	8.4	4.2
238	30	2	1	”	11.2	”	5.6	8.4	4.2
254	30	2	1	”	11.2	”	5.6	8.4	4.2
357	30	3	1	”	16.8	”	8.4	12.6	6.3
381	30	3	1	”	16.8	”	8.4	12.6	6.3
446	30	4	1	”	22.4	”	11.2	16.8	8.4
476	30	4	1	”	22.4	”	11.2	16.8	8.4
509	30	4	1	”	22.4	”	11.2	16.8	8.4
595	30	5	1	”	28.0	”	14.0	21.0	10.5
636	30	5	1	”	28.0	”	14.0	21.0	10.5
714	30	6	1	note 1	33.6	note 1	16.8	25.2	12.6
763	30	6	1	”	33.6	”	16.8	25.2	12.6
893	30	8	1	”	44.8	”	22.4	33.6	16.8
952	30	8	1	”	44.8	”	22.4	33.6	16.8
1017	30	8	1	”	44.8	”	22.4	33.6	16.8
1116	30	10	1	”	56.0	”	28.0	42.0	21.0
1190	30	10	1	”	56.0	”	28.0	42.0	21.0
1271	30	10	1	”	56.0	”	28.0	42.0	21.0
1425	36	10	2	note 1	86.0	note 1	43.0	93.7	46.9
1502	36	10	2	”	86.0	”	43.0	93.7	46.9
1625	36	10	2	”	86.0	”	43.0	93.7	46.9

Notes:

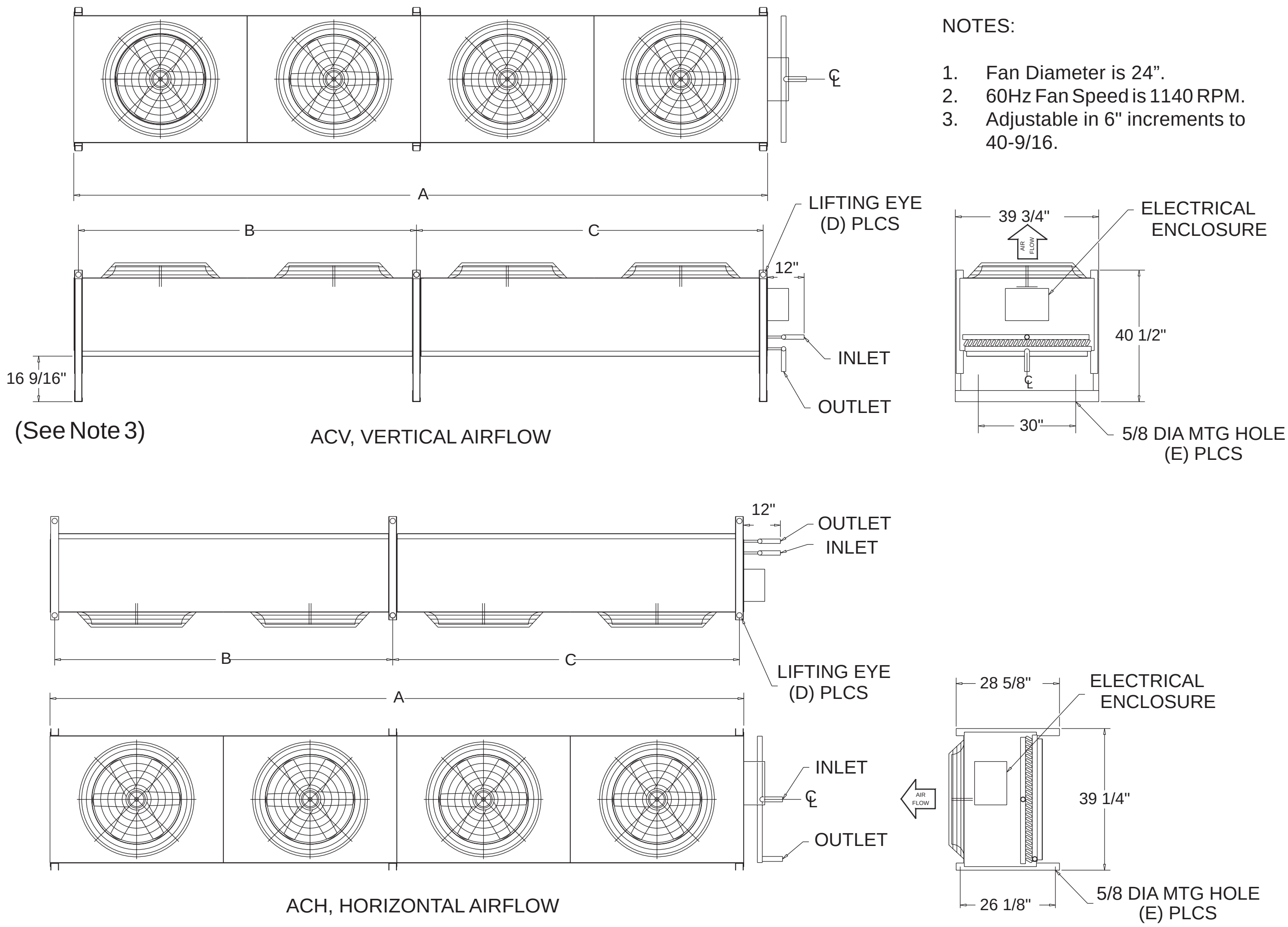
1. These units not available for single phase supply.
2. Models 62 through 384 (24” Fans)
   Standard motors are 3/4 HP, 1140 RPM ODP, 60 Hz with internal thermal overload protection.
   Models 119 through 1271 (30” Fans)
   Standard motors are 1 HP, 850 RPM ODP, 60 Hz with internal thermal overload protection.
   Models 1425 through 1625 (36” Fans)
   Standard motors are 2 HP, 850 RPM TEFC, 60 Hz without internal thermal overload protection.
3. For 50 Hz operation: 1 HP motors are used in lieu of 3/4 HP.
   (see page 10) 1-1/2 HP motors are used in lieu of 1 HP.
   2 HP motors are 950 RPM, 2 HP.

WIRING:

Colmac ACV/ACH condensers are factory wired for single-point wiring in the field. A fused disconnect is available as an option. Fan motors on models 62 thru 1271 have internal thermal overload protection. Motors on models 1425 thru 1625 have individual overload relays/fuses provided in the factory electrical enclosure. On all units, with and without fan cycle controls, individual motor leads terminate in the electrical enclosure.

When field wiring these condensers, follow NEC and applicable local codes.

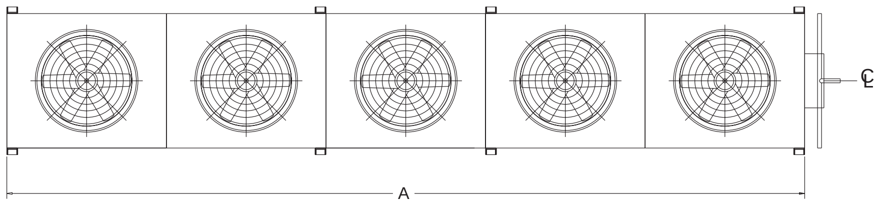
FIGURE 1
PHYSICAL DIMENSIONS, Models 62 thru 384
(24" dia fans)



DIMENSIONS

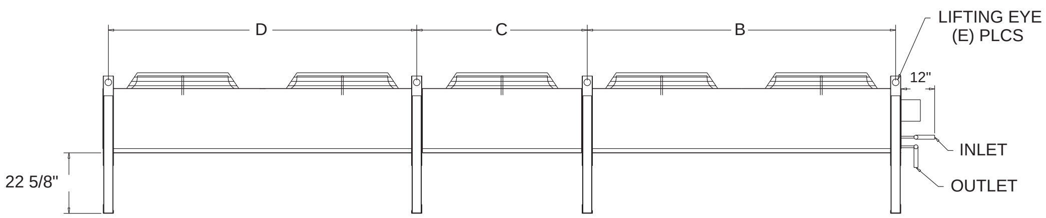
MODEL	NO. FANS	A	B	C	D	E	GAS INLET ODS	LIQ. OUTLET ODS
62	1	48	46	-	4	4	1 1/8	7/8
84	1	48	46	-	4	4	1 1/8	7/8
96	1	48	46	-	4	4	1 1/8	7/8
167	2	96	94	-	4	4	1 3/8	7/8
192	2	96	94	-	4	4	1 3/8	7/8
251	3	144	94	48	6	6	1 5/8	1 1/8
288	3	144	94	48	6	6	1 5/8	1 1/8
307	4	192	94	96	6	6	1 5/8	1 1/8
335	4	192	94	96	6	6	1 5/8	1 1/8
384	4	192	94	96	6	6	2 1/8	1 1/8

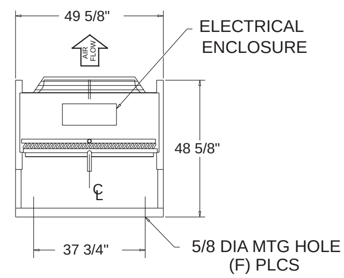
FIGURE 2
PHYSICAL DIMENSIONS, Models 119 thru 636
(30" dia fans)



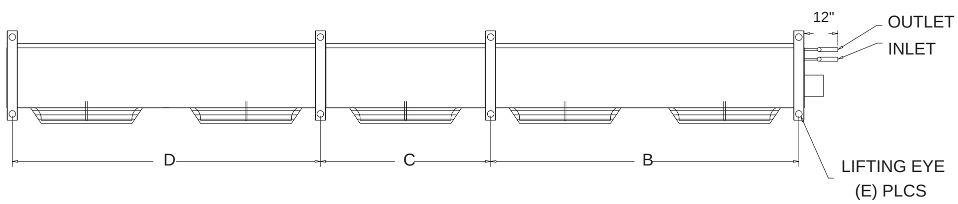
NOTES:

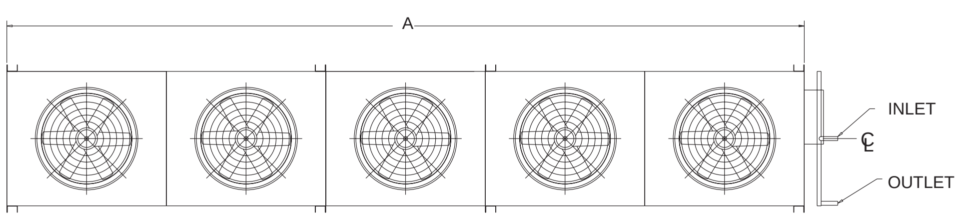
1. Fan Diameter is 30".
2. 60Hz Fan Speed is 850 RPM. Single Phase Motors Not Available.
3. Adjustable in 7-9/16" increments to 37-3/4.

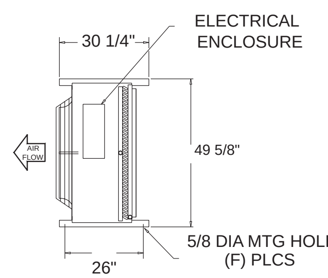




(See Note 3) ACV, VERTICAL AIRFLOW





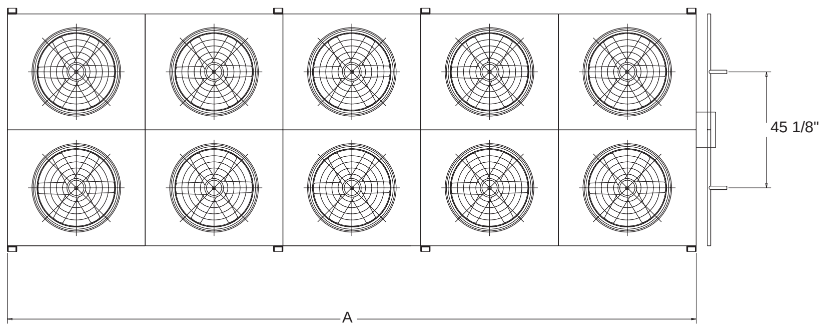


ACH, HORIZONTAL AIRFLOW

DIMENSIONS

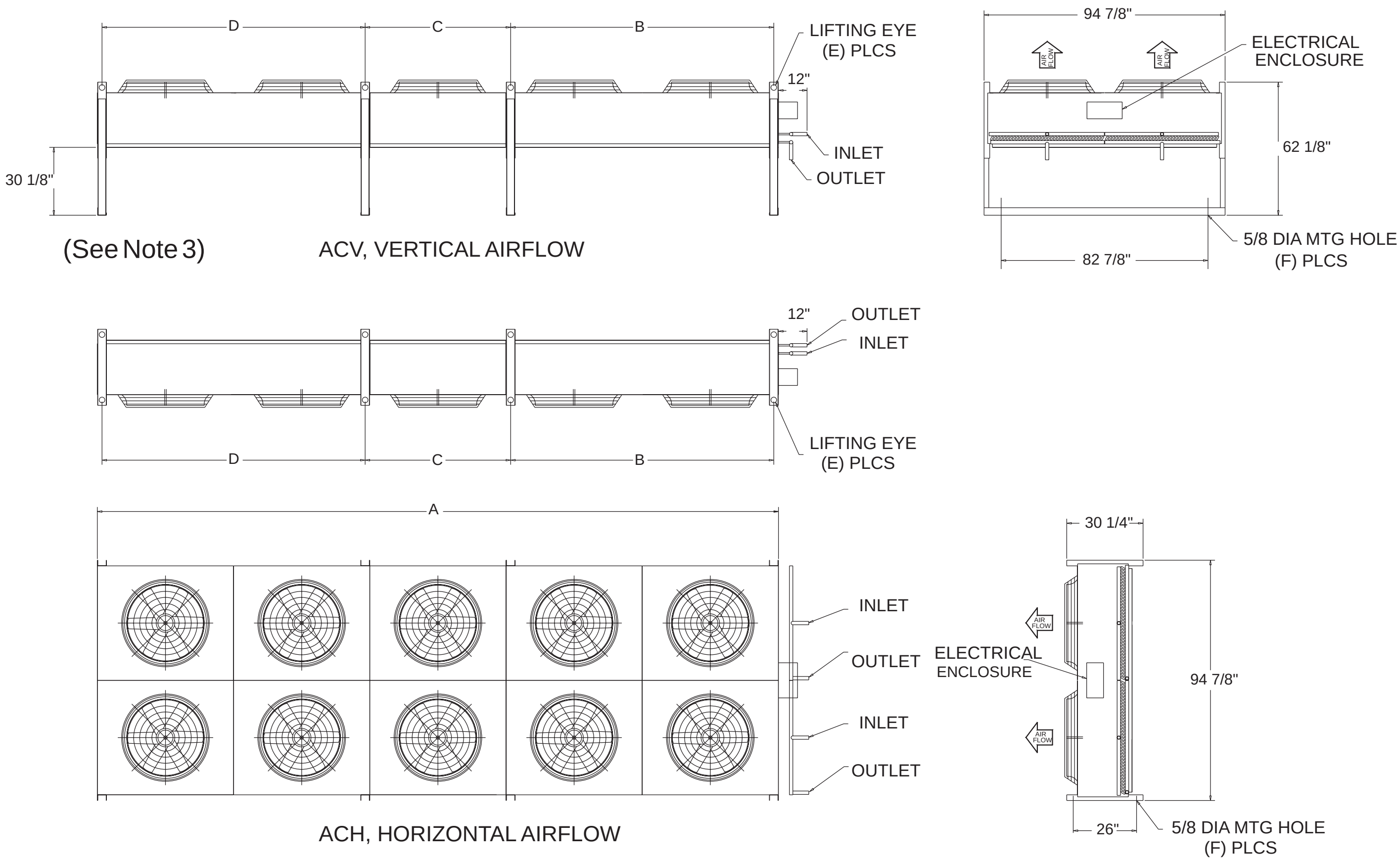
MODEL	NO. FANS	A	B	C	D	E	F	GAS INLET ODS	LIQ. OUTLET ODS
119	1	54	50 1/2	-	-	4	4	1 3/8	7/8
127	1	54	50 1/2	-	-	4	4	1 3/8	7/8
223	2	108	104 1/2	-	-	4	4	1 5/8	7/8
238	2	108	104 1/2	-	-	4	4	1 5/8	1 1/8
254	2	108	104 1/2	-	-	4	4	1 5/8	1 1/8
357	3	162	104 1/2	-	54	6	6	2 1/8	1 1/8
381	3	162	104 1/2	-	54	6	6	2 1/8	1 1/8
446	4	216	104 1/2	-	108	6	6	2 1/8	1 1/8
476	4	216	104 1/2	-	108	6	6	2 1/8	1 3/8
509	4	216	104 1/2	-	108	6	6	2 1/8	1 3/8
595	5	270	104 1/2	57 1/2	104 1/2	8	8	2 1/8	1 3/8
636	5	270	104 1/2	57 1/2	104 1/2	8	8	2 1/8	1 3/8

FIGURE 3
PHYSICAL DIMENSIONS, Models 714 thru 1271
(30" dia fans)



NOTES:

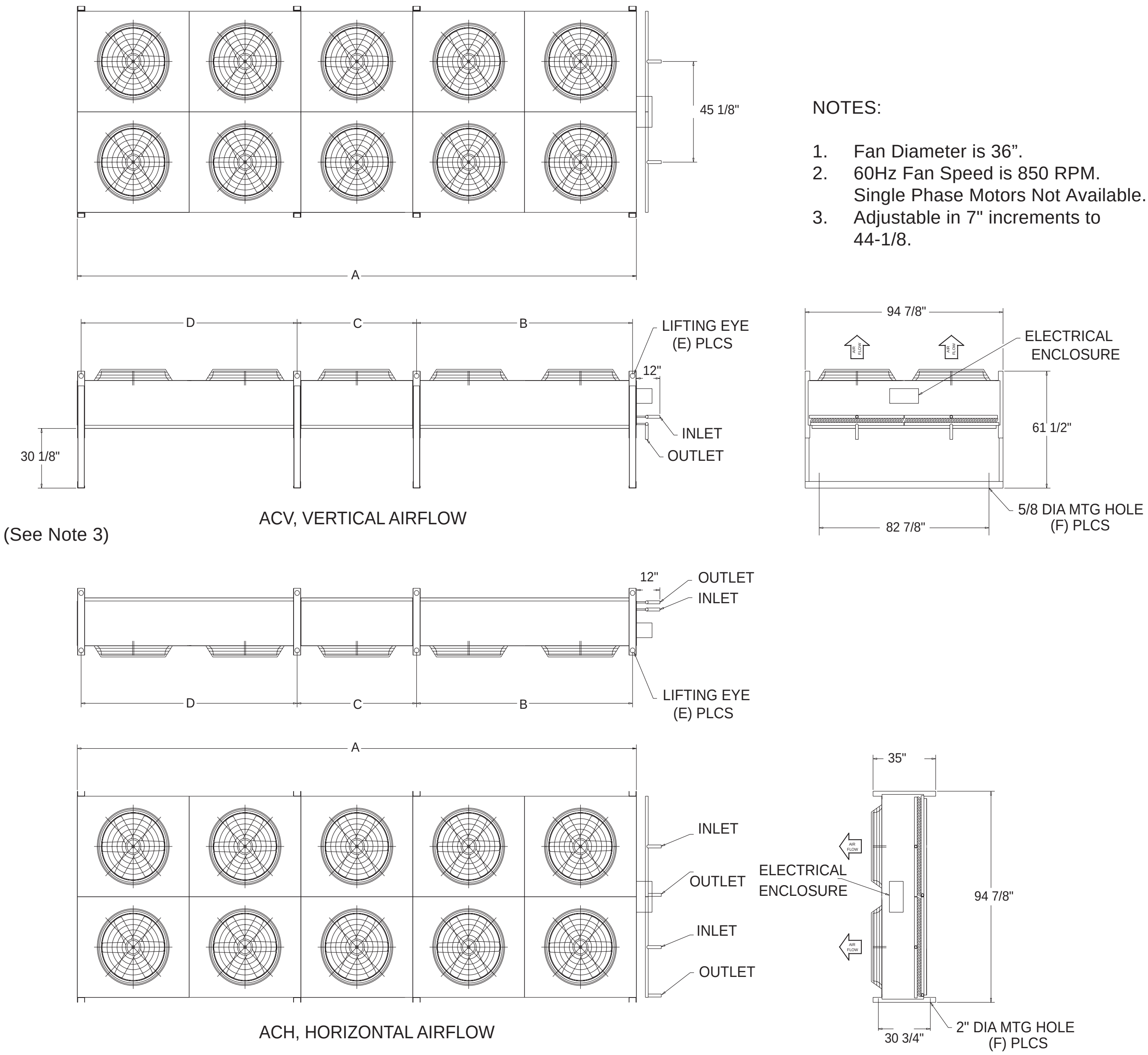
1. Fan Diameter is 30”.
2. 60Hz Fan Speed is 850 RPM. Single Phase Motors Not Available.
3. Adjustable in 7-9/16" increments to 45-1/4.



DIMENSIONS

MODEL	NO. FANS	A	B	C	D	E	F	GAS INLET ODS	LIQ. OUTLET ODS
714	6	162	104 1/2	-	54	6	6	(2) 2 1/8	(2) 1 1/8
763	6	162	104 1/2	-	54	6	6	(2) 2 1/8	(2) 1 1/8
893	8	216	104 1/2	-	108	6	6	(2) 2 1/8	(2) 1 1/8
952	8	216	104 1/2	-	108	6	6	(2) 2 1/8	(2) 1 3/8
1017	8	216	104 1/2	-	108	6	6	(2) 2 1/8	(2) 1 3/8
1116	10	270	104 1/2	57 1/2	104 1/2	8	8	(2) 2 1/8	(2) 1 3/8
1190	10	270	104 1/2	57 1/2	104 1/2	8	8	(2) 2 1/8	(2) 1 3/8
1271	10	270	104 1/2	57 1/2	104 1/2	8	8	(2) 2 1/8	(2) 1 3/8

FIGURE 4
PHYSICAL DIMENSIONS, Models 1425 thru 1625
(36" dia fans)



NOTES:

1. Fan Diameter is 36".
2. 60Hz Fan Speed is 850 RPM. Single Phase Motors Not Available.
3. Adjustable in 7" increments to 44-1/8.

DIMENSIONS

MODEL	NO. FANS	A	B	C	D	E	F	GAS INLET ODS	LIQ. OUTLET ODS
1425	10	270	104 1/4	57 3/4	104 1/4	8	8	(2) 2 1/8	(2) 1 3/8
1502	10	270	104 1/4	57 3/4	104 1/4	8	8	(2) 2 1/8	(2) 1 3/8
1625	10	270	104 1/4	57 3/4	104 1/4	8	8	(2) 2 5/8	(2) 1 5/8

CONDENSER SIZING:

Colmac ACV, and ACH air-cooled condensers are designed for use in standard commercial and industrial refrigeration, and air conditioning systems. These units reject heat from the refrigerant to ambient air as the refrigerant leaves the compressor. Typically, the refrigerant is first desuperheated, then condensed from vapor to liquid within the condenser.

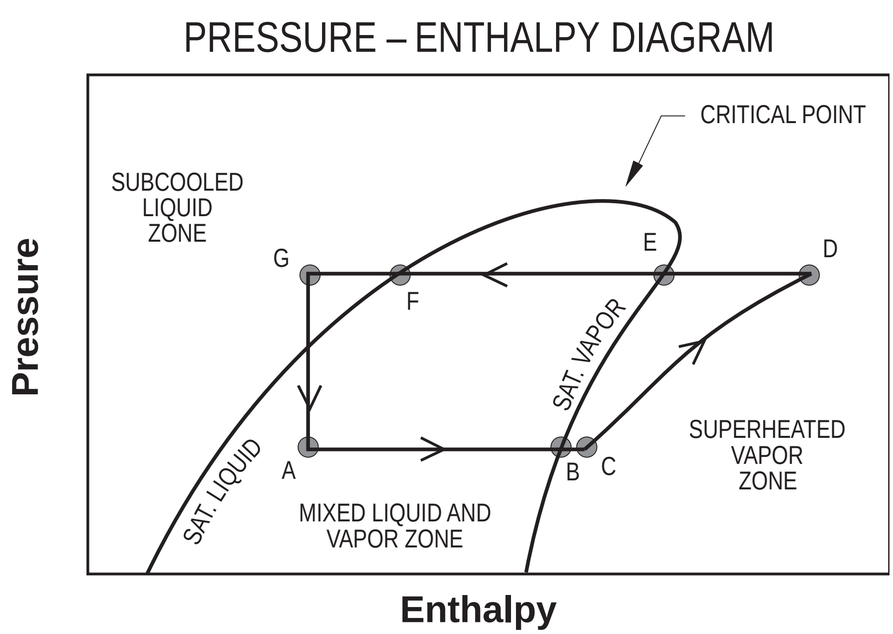
To illustrate the vapor compression cycle, a pressure-enthalpy (p-h) diagram for refrigerant properties is often used. Figure 5 shows such a diagram with the “idealized” (frictionless) vapor compression cycle superimposed. The dome shaped region represents a condition of coexisting vapor and liquid. The typical process that takes place within this “vapor dome” is either evaporation (moving from left to right), or condensation (moving from right to left). Both processes, for practical purposes, take place at constant pressure and temperature. Further, evaporation absorbs heat from the surroundings, while condensing gives up heat to the surroundings.

Outside the vapor dome, refrigerant vapor is either being heated (superheated), or cooled (desuperheated), and liquid is being cooled (subcooled). Saturated Condensing Temperature is that constant temperature at which condensing is taking place within the vapor dome, inside the condenser. Note there will also be a Saturation Pressure which corresponds to the Saturation Temperature for evaporating and condensing.

The points labeled A thru G on Figure 5 represent the main processes of interest to our discussion:

- A to B - Constant pressure/temperature evaporation in the evaporator.
- B to C - Superheating at the evaporator exit required for Thermostatic Expansion Valve (TXV) operation.
- C to D - Constant entropy compression of vapor in the compressor.
- D to E - Desuperheating at the condenser entrance.
- E to F - Constant pressure/temperature condensing in the condenser.
- F to G - Subcooling of liquid in the subcooler coil.
- G to A - Pressure drop and expansion, at constant enthalpy, of refrigerant through the liquid line, TXV, and distributor.

FIGURE 5



TOTAL HEAT OF REJECTION, THR:

Notice that the heat (i.e.: enthalpy change) rejected from the condenser, shown as points D to F in Figure 5, is larger than the heat absorbed in the evaporator, shown as points A to C. In fact, the heat rejected from the condenser, called Total Heat of Rejection (THR), is equal to the evaporator heat input plus the compressor work input.

It is this Total Heat of Rejection that the designer must size the condenser for. THR (in MBH) can be easily calculated if one knows the compressor evaporator capacity, and input power.

I. For Open Drive Compressors

THR = Compressor capacity (in MBH) + (Motor BHp x 2.545)

II. For Semi-Hermetic, or Hermetic Compressors (Suction - cooled)

THR = Compressor capacity (in MBH) + (Input kW x 3.413)

For single stage systems, if the compressor input power is not known, then an estimate of THR can be calculated using Tables 4 and 5. THR for two-stage, and compound systems should be calculated based on heat and work inputs per the above formulas. To use the tables, find the design saturated suction and condensing temperatures, and determine the factor. So,

THR = Evaporator load x factor

TABLE 4
THR FACTORS, Open Drive Compressors

Suction	**Condensing Temp., F**					
Temp., F	**90**	**100**	**110**	**120**	**130**	**140**
-40	1.43	1.48	1.54	*	*	*
-30	1.37	1.42	1.47	*	*	*
-20	1.33	1.37	1.42	1.47	*	*
-10	1.28	1.32	1.37	1.42	1.47	*
0	1.24	1.28	1.32	1.37	1.41	1.47
10	1.21	1.24	1.28	1.32	1.36	1.42
20	1.17	1.20	1.24	1.28	1.32	1.37
30	1.14	1.17	1.20	1.24	1.27	1.32
40	1.12	1.15	1.17	1.20	1.23	1.28
50	1.09	1.12	1.14	1.17	1.20	1.24

* Outside normal pressure ratio, and discharge temperature limits for single stage compressors.

TABLE 5
THR FACTORS, Hermetic and Semi-Hermetic Compressors

Suction	**Condensing Temp., F**					
Temp., F	**90**	**100**	**110**	**120**	**130**	**140**
-40	1.66	1.73	1.80	2.00	*	*
-30	1.57	1.62	1.68	1.80	*	*
-20	1.49	1.53	1.58	1.65	*	*
-10	1.42	1.46	1.50	1.57	1.64	*
0	1.36	1.40	1.44	1.50	1.56	1.62
10	1.31	1.34	1.38	1.43	1.49	1.55
20	1.26	1.29	1.33	1.37	1.43	1.49
30	1.22	1.25	1.28	1.32	1.37	1.42
40	1.18	1.21	1.24	1.27	1.31	1.35
50	1.14	1.17	1.20	1.23	1.26	1.29

* Outside normal pressure ratio, and discharge temperature limits for single stage compressors.

DISCHARGE TEMPERATURE AND PRESSURE LIMITS:

At large compression ratios, (where compr. ratio = condensing pressure ÷ suction pressure), the refrigerant gas temperature leaving the compressor can become high enough to burn the compressor lubricating oil.

This maximum discharge gas temperature is between 275 - 300°F, depending on type of oil used (check compressor manufacturer's recommended limits).

Discharge gas temperature can be estimated for semi-hermetic, and hermetic compressors by adding 45°F to the gas temperature found at the end of constant entropy compression (process C to D in Figure 5) on the refrigerant p-h diagram. For open drive compressors, add 30°F to the gas temperature found at the end of constant entropy compression.

Reciprocating compressors are also limited to some maximum compression ratio. This maximum compression ratio varies, and the designer should be careful to operate within the manufacturer's limits.

INITIAL TEMPERATURE DIFFERENCE, TD:

Colmac air-cooled condenser capacity is proportional to the Initial Temperature Difference (TD), defined as;

TD = Saturated Condensing Temp. - Ambient Air Temp.

Unit capacities at various TD's are shown in Table 1. Capacities are given in MBH, where;

1 MBH = 1000 BTUH (1000 British Thermal Units per hour)

Table 6 below shows suggested design TD's to keep discharge gas temperature, and compression ratio within recommended limits (check compressor manufacturer's specific requirements).

TABLE 6
SUGGESTED DESIGN TD'S

Application	**TD**
Low Temp. Refrigeration	15 F
High and Medium Temp. Refrigeration	20 F
Air Conditioning	20 F

FACTORS AFFECTING PERFORMANCE:

1. **Altitude.** Capacities shown in the tables are based on operation at sea level. As elevation increases, air density decreases, which results in reduced air mass flow and reduced capacity. Table 7 below gives factors for calculating reduced capacity due to increased elevation. To determine condenser performance at design elevation, multiply the unit rating shown in Table 1 by the factor. So,

   Capacity (@ design elev) = Rated capacity (Table 1) X factor (Table 7)

TABLE 7
ELEVATION CAPACITY CORRECTION FACTOR

Elevation AMSL, ft (AMSL = Above Mean Sea Level)	**Factor**
0	1.00
1,000	0.98
2,000	0.95
3,000	0.93
4,000	0.91
5,000	0.89
6,000	0.87
8,000	0.83
10,000	0.74

2. **Subcooling.** Addition of a subcooling coil will increase system capacity by some amount. The designer should be careful to take the increased system capacity into account when sizing refrigerant lines, the evaporator, TX valve, etc. See the section on SUBCOOLING for a complete explanation of subcooler sizing.

OPERATION WITH 50 Hz POWER

COLMAC AFV and AFH fluid coolers are designed to operate with either 60 Hz, or 50 Hz supply power. Cooling capacity for 50 Hz operation will be the same as capacity for 60 Hz operation, since COLMAC uses fan blades matched to the 50 Hz rotational speed of 950 RPM.

Motor horsepower on most models will be different, however. The 60 Hz, 3/4 HP motors will be replaced with 1.0 HP motors, and 60 Hz, 1.0 HP motors will be replaced with 1.5 HP motors for 50 Hz operation.

50 Hz FAN SPEED/SOUND LEVEL:

Operation of fluid coolers at 50 Hz will change the rotational speed of the fans. All fans will turn at 950 RPM. The 24 in. dia. fans will turn slower that those used for 60 Hz operation, and will run quieter. The 30 and 36 in. dia. fans will turn faster than those used for 60 Hz operation and will be somewhat louder. Fan and tip speeds, and sound levels for 60 Hz and 50 Hz are shown in tables 3 and 4.

TABLE 8
FAN SPEEDS

		60 Hz		50 Hz	
Models	**Fan Dia**	**Fan RPM**	**Tip Spd FPM**	**Fan RPM**	**Tip Spd FPM**
62 thru 384	24"	1140	7163	950	5969
119 thru 1271	30"	850	6676	950	7464
1425 thru 1625	36"	850	8011	950	8958

TABLE 9
ACV/ACH SOUND LEVELS (Approx.)*

	60 Hz Operation dBA @ Distance from Unit, Ft				50 Hz Operation dBA @ Distance from Unit, Ft			
No. Fans	**5’**	**25’**	**50’**	**100’**	**5’**	**25’**	**50’**	**100’**
24 dia								
1	70	56	50	44	66	52	46	40
2	73	59	53	47	69	55	49	43
3	75	61	55	49	71	57	51	45
4	76	62	56	50	72	58	52	46
30 dia								
1	69	55	49	43	71	57	51	45
2	72	58	52	46	74	60	54	48
3	74	60	54	48	76	62	56	50
4	75	61	55	49	77	63	57	51
5	76	62	56	50	78	64	58	52
6	77	63	57	51	79	65	59	53
8	78	64	58	52	80	66	60	54
10	79	65	59	53	81	67	61	55
36 dia								
10	85	71	65	59	87	73	67	61

*Based on free field sound data, with no background noise.

SELECTION PROCEDURE:

Use the following general procedure for selecting Colmac ACV/ACH air-cooled condensers:

Step 1: Calculate the design THR (page #12).

Step 2: Determine the design TD (page #13).

Step 3: Select a condenser from Table 1 (page #6), with capacity equal to or greater than design THR, at the design TD.

Step 4: Calculate the adjusted capacity by applying the appropriate correction factors for elevation, and 50 Hz power, given in "Factors Affecting Performance" (page #13).

Step 5: Check the adjusted capacity to be sure it is still equal to or greater than design THR.

Step 6: On multi-system condensers, determine the number of circuits per system, and the proper connection sizes for each system.

SINGLE SYSTEM CONDENSER SIZING, EXAMPLE 1:

A single system condenser is one rejecting heat for a single compressor, or multiple compressors piped into a common parallel refrigerant system.

Design Conditions:

Application:	Air Conditioning
Summer Ambient:	100F
Sat. Condensing Temp.:	120F
Refrigerant:	R22
Compressor Capacity(Evap):	37.6 Tons
Compressor Type:	Open Drive Reciprocating
Compressor BHp:	44.4 Hp
Supply Power:	60 Hz
Elevation:	5000 ft AMSL

Step 1: Compressor Capacity, in MBH = 37.6 x 12 = 451.2 MBH

THR = 451.2 + (44.4 BHp x 2.545) = 564.2 MBH

Step 2: Design TD = 120 - 100 = 20 °F

Step 3: From Table 1, pick Model ACV-595, which has capacity of 594.8 MBH.

Step 4: A correction for elevation needs to be made, factors are shown in Table 7. The factor for 5000 ft is 0.89

Adjusted Capacity = 594.8 x 0.89 = 529.4 MBH

Step 5: The adjusted capacity for model ACV-595 has fallen below the 564.2 MBH required. So, the next size larger model will be selected, that is, ACV-636.

Repeat Step 4: Adjusted capacity = 635.7 x 0.89 = 565.8 MBH

Step 5: This model's adjusted capacity is greater than the 564.2 MBH required, and is acceptable.

MULTI-SYSTEM CONDENSER SIZING, EXAMPLE 2:

A multiple system condenser is one which rejects heat for more than one compressor. Each compressor is typically piped separately, with corresponding separate inlet, and outlet connections at the condenser.

Design Conditions:

Application:	Supermarket Refrigeration
Summer Ambient:	100F
Compressor Type:	Semi-Hermetic (suction cooled)
Supply Power:	60 Hz
Elevation:	2000 ft AMSL

Compressor Capacities:

System	Suction Temp	Descrip	Compressor Capacity,BTUH	Input kW	Design TD (cond.)
1	20	Meat Clr	45,000	7.27	20
2	20	Fish Clr	10,000	1.62	20
3	20	Dairy Clr	45,000	7.27	20
4	20	Deli Clr	15,000	2.42	20
5	25	Prod Clr	19,000	2.83	20
6	30	Meat Prep	48,000	6.69	20
7	15	Deli Case	50,000	8.69	15
8	10	Frz Meat	21,900	4.22	15
9	-20	Frz Bakry	6,000	1.00	15
10	-25	Food Frz	36,000	6.48	10
11	-20	Meat Frz	40,000	6.65	15
12	-20	Food Frz	25,000	4.15	15

Step 1: To calculate THR for multi-circuit condenser sizing, the designer needs to calculate THR on a per degree basis (MBH/1 deg TD). Tabulate these values as follows:

System	Capacity, MBH	+	(kW x 3.41) MBH	=	THR, MBH	/	Design TD	=	THR/deg
1	45.0	+	24.79	=	69.79	/	20	=	3.49
2	10.0	+	5.52	=	15.52	/	20	=	0.78
3	45.0	+	24.79	=	69.79	/	20	=	3.49
4	15.0	+	8.25	=	23.25	/	20	=	1.16
5	19.0	+	9.65	=	28.65	/	20	=	1.43
6	48.0	+	22.81	=	70.81	/	20	=	3.54
7	50.0	+	29.63	=	79.63	/	15	=	5.31
8	21.9	+	14.39	=	36.29	/	15	=	2.42
9	6.0	+	3.41	=	9.41	/	15	=	0.63
10	36.0	+	22.10	=	58.10	/	10	=	5.81
11	40.0	+	22.68	=	62.68	/	15	=	4.18
12	25.0	+	14.15	=	39.15	/	15	=	2.61

Total THR/deg F = 34.85

Step 2: We have integrated the design TD's for the various systems into a total required THR/deg F of 34.85 MBH/deg F.

Step 3: From Table 1, pick Model ACV-763, which has a capacity of 38.142 MBH per deg F.

Step 4: A correction for elevation needs to be made, factors are shown in Table 7. The factor for 2000 ft is 0.95

Adjusted Capacity = 38.142 x 0.95 = 36.23 MBH/deg F

Step 5: The adjusted capacity of 36.23 MBH/deg F for Model ACV-763 is above the 34.85 MBH/deg F required, and is acceptable.

Step 6: To determine the number of circuits per system, and the proper connection sizes for each system, tabulate as follows (this calculation can be done at the factory upon request):

System	THR/deg /	Total THR/deg	=	Condenser Fraction Used	x	Total Avail cts	=	No. cts Req'd	Integer No. cts
1	3.49 /	34.85	=	0.100	x	36	=	3.60	4
2	0.78 /	34.85	=	0.022	x	36	=	0.79	1
3	3.49 /	34.85	=	0.100	x	36	=	3.60	4
4	1.16 /	34.85	=	0.033	x	36	=	1.19	1
5	1.43 /	34.85	=	0.041	x	36	=	1.48	2
6	3.54 /	34.85	=	0.102	x	36	=	3.67	4
7	5.31 /	34.85	=	0.152	x	36	=	5.47	5
8	2.42 /	34.85	=	0.069	x	36	=	2.48	2
9	0.63 /	34.85	=	0.018	x	36	=	0.65	1
10	5.81 /	34.85	=	0.167	x	36	=	6.01	5
11	4.18 /	34.85	=	0.120	x	36	=	4.32	4
12	2.61 /	34.85	=	0.075	x	36	=	2.70	3
					Total cts.->	36		must equal->	36

Total number of available circuits can be found in Table 2.

Note that the designer will have to make some judgements in deciding whether to round the number of circuits up or down for each system. The operating TD for each system will vary from design TD because of this rounding process. The following tabulations calculate operating TD's, and connection sizes.

System	Integer No. cts	/	Total No. cts	=	Condenser Fraction	x	Total Adjusted MBH/deg	=	Oper. MBH/deg
1	4	/	36	=	0.111	x	36.23	=	4.022
2	1	/	36	=	0.028	x	36.23	=	1.014
3	4	/	36	=	0.111	x	36.23	=	4.022
4	1	/	36	=	0.028	x	36.23	=	1.014
5	2	/	36	=	0.055	x	36.23	=	1.993
6	4	/	36	=	0.111	x	36.23	=	4.022
7	5	/	36	=	0.139	x	36.23	=	5.036
8	2	/	36	=	0.055	x	36.23	=	1.993
9	1	/	36	=	0.028	x	36.23	=	1.014
10	5	/	36	=	0.139	x	36.23	=	5.036
11	4	/	36	=	0.111	x	36.23	=	4.022
12	3	/	36	=	0.083	x	36.23	=	3.007

Now calculate operating TD's for each system, and pick connection sizes using Table 10.

System	Design THR, MBH	/	Oper. MBH/deg	=	Oper. TD	Gas Inlet, ODS	Liq. Outlet ODS
1	69.79	/	4.022	=	17.4	1 1/8	5/8
2	15.52	/	1.014	=	15.3	1/2	1/2
3	69.79	/	4.022	=	17.4	1 1/8	5/8
4	23.25	/	1.014	=	22.9	1/2	1/2
5	28.65	/	1.993	=	14.4	1/2	1/2
6	70.81	/	4.022	=	17.6	1 1/8	5/8
7	79.63	/	5.036	=	15.8	1 1/8	5/8
8	36.29	/	1.993	=	18.2	7/8	5/8
9	9.41	/	1.014	=	9.3	1/2	1/2
10	58.10	/	5.036	=	11.5	1 1/8	5/8
11	62.68	/	4.022	=	15.6	1 1/8	7/8
12	39.15	/	3.007	=	13.0	1 1/8	5/8

Note where the number of circuits per system equals one (1), the gas inlet and liquid outlet connections will be 1/2 ODS. This completes the Multi-System Condenser sizing procedure.

TABLE 10
MULTI-SYSTEM CONDENSER CONNECTION CAPACITIES, MBH

Connec. Size, ODS	R22 Gas	R22 Liquid	R502 Gas	R502 Liquid
1/2	9.0	43.2	6.7	28.8
5/8	16.8	80.4	12.0	54.0
7/8	44.4	218.4	32.4	141.6
1 1/8	90.0	444.0	66.0	289.2
1 3/8	157.2		115.2	
1 5/8	248.4		182.4	
2 1/8	513.6		376.8	

SUBCOOLING:

Subcooling refrigerant liquid is typically done for two reasons: 1) To increase system capacity, and/or 2) To eliminate flash gas (refrigerant that has boiled from liquid to vapor) in the liquid line upstream of the TX valve.

1. **Increase in System Capacity:** Subcooling refrigerant liquid not only prevents flash gas in liquid lines, but is accompanied by an increase in compressor capacity of approximately 0.5% for every 1 degree F of subcooling (See Figure 6). This rule applies to subcooling done by ambient means only (see below). Subcooling by liquid pumping, or mechanical means does not increase compressor capacity directly.

   Some compressor ratings assume some amount of subcooling, others do not. It is important, therefore, to know the basis of the compressor ratings, and adjust capacity accordingly. The designer then needs to take increased compressor capacity into account when sizing all system components (i.e., lines, control valves, evaporators, condenser, etc.).

   Subcooler Location: The location of the subcooler is important relative to the liquid receiver. Subcooling should always be done immediately downstream of the receiver, never between the condenser and the receiver. If the subcooler is located between condenser and receiver, any subcooling done is eliminated, and it's benefit lost in the receiver. See Figure 7.

2. **Eliminating Flash Gas:** Refrigerant liquid leaving the condenser is typically at saturation. If the liquid has not been subcooled before it enters the liquid line, any drop in pressure, or any heat input, will cause the liquid to boil, and "flash gas" is formed. This flash gas will cause an excessive pressure drop in the liquid line, and will greatly reduce the capacity of the TX valve, and the system. Adequate subcooling of the liquid will prevent the formation of flash gas.

   Subcooling the liquid after it leaves the receiver is obviously a necessity for proper system operation. Again, note that subcooling done between the condenser and the receiver will be eliminated in the receiver, and is generally poor practice. The amount of subcooling required corresponds to the liquid line pressure drop. This pressure drop is the sum of: 1) the loss in pressure due to elevation gain in the liquid line, and 2) liquid line pressure drop due to friction. Table 11 shows the pressure drop in liquid lines produced by elevation gain between the receiver and evaporators.

TABLE 11
PRESSURE DROP IN LIQUID LINES DUE TO ELEVATION GAIN

Elevation gain, feet	Pressure Drop, psi R22/R502
1	0.56
5	2.78
10	5.56
15	8.33
20	11.1
25	13.9
30	16.7
35	19.4
40	22.2
45	25.0
50	27.8

Once the total liquid line pressure drop (the sum of elevation pressure drop plus friction pressure drop) is calculated, the required amount of subcooling to prevent flash gas in the line can be determined from Table 12. Note that the amount of subcooling required for a given pressure drop increases as condensing temperature decreases.

TABLE 12
LIQUID SUBCOOLING REQUIRED TO PREVENT FLASH GAS

Total Liquid Line	Req'd Amt of Subc, F, R22/R502		
Pressure Drop, psi	**110F Cond.**	**70F Cond.**	**30F Cond.**
1	0.328	0.490	0.815
4	1.31	1.96	3.26
6	1.97	2.94	4.89
8	2.62	3.92	6.52
10	3.28	4.90	8.15
12	3.94	5.88	9.78
14	4.59	6.86	11.4
16	5.25	7.84	13.0
18	5.90	8.82	14.7
20	6.56	9.80	16.3
25	8.20	12.3	20.4
30	9.84	14.7	24.5
35	11.5	17.2	28.5
40	13.1	19.6	32.6
45	14.8	22.1	36.7
50	16.4	24.5	40.8

Methods of Subcooling: There are three ways to effectively subcool the liquid refrigerant leaving the receiver: 1) Ambient subcooling, 2) Liquid pump, and/or 3) Mechanical subcooling.

1. **Ambient Subcooling -** requires the addition of a separate subcooling coil to the ACV condenser. One fan must be left running continuously, to draw air through the subcooler coil during all operating conditions. The amount of subcooling that can be achieved with this method is limited by the condenser operating TD. Capabilities of ambient subcooling are shown in Figure 6.

   It is important to realize that the operating TD of the condenser will decrease as the system is unloaded, and reduce the amount of subcooling available with this method. Condenser capacity is proportional to TD, so for example, if the design TD is 20°F, and compressors are unloaded by 50%, then the unloaded operating condenser TD will be:

   $0.50 \times 20 = 10°F$ TD

   Ambient subcooling will be reduced to the amount shown in Figure 6 for the new unloaded operating TD. Ambient subcooling coil should be used only with Colmac type FC low ambient control, or with no low ambient control.

2. **Liquid Pump -** is a centrifugal refrigerant pump installed at the outlet of the receiver to boost the pressure of the liquid before it enters the liquid line. This increase in pressure effectively "subcools" the liquid, but does not increase compressor capacity as in method 1.

   The pumps used are patented, and are capable of raising liquid pressure by 12 to 15 psi. This pressure increase due to the pump is subtracted from the total liquid line pressure drop. If a pressure increase greater than 12 to 15 psig is required to prevent flash gas, pumps can be piped in series to produce 24 to 30 psi. Also, liquid pumping can be used in conjunction with other subcooling methods.

   This system works well for floating head pressure systems where subcooling is required (generally always), and all condenser fans are shut off under low ambient conditions. Colmac Type LP liquid pumping can be used alone, or with Type FC, or MS low ambient controls.

FIGURE 6
AMBIENT SUBCOOLER PERFORMANCE

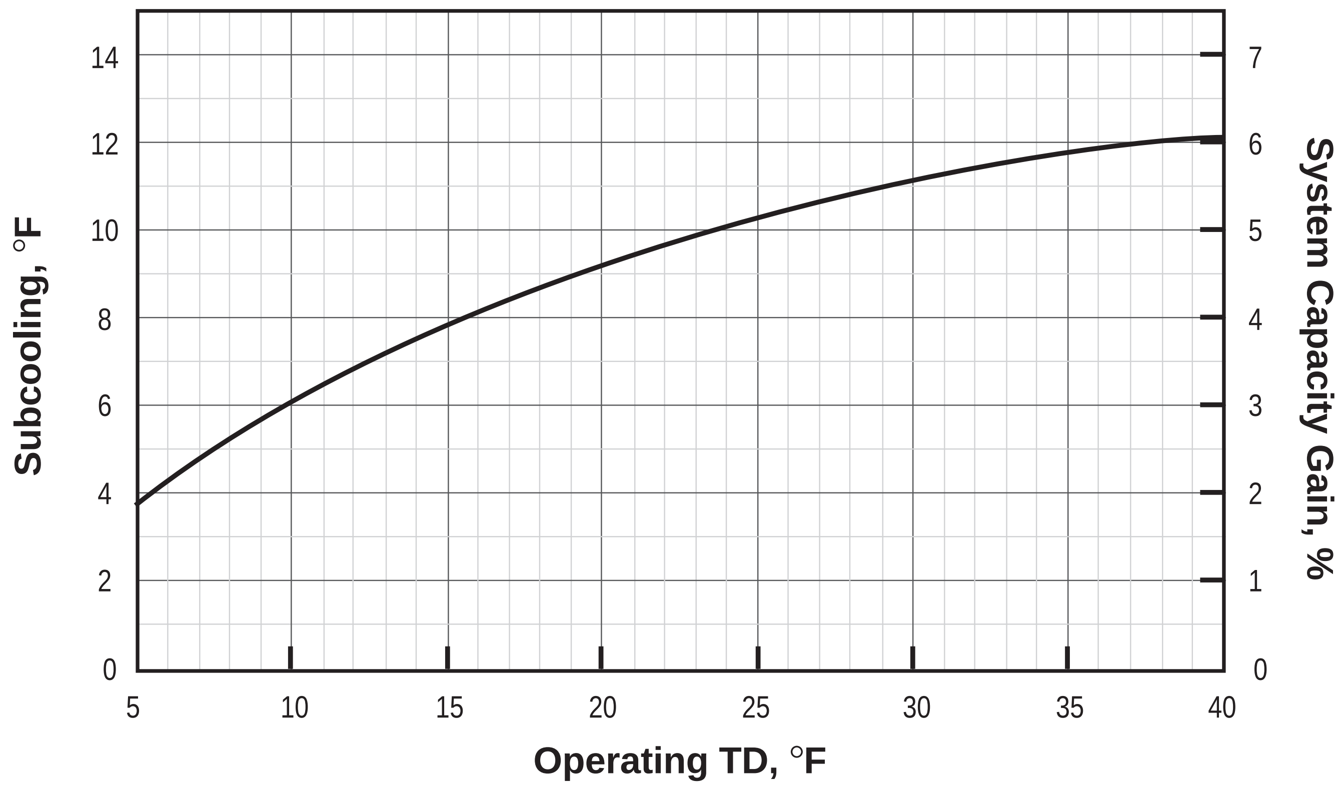
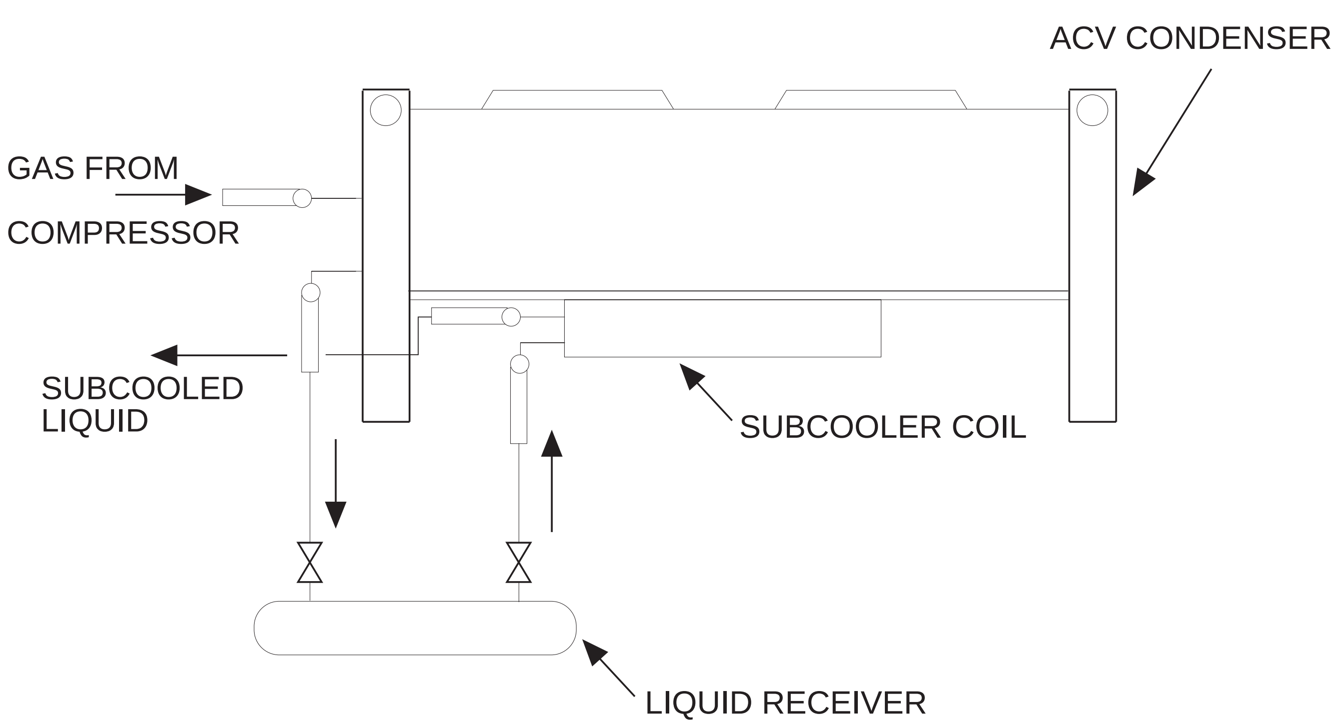


FIGURE 7
RECOMMENDED SUBCOOLER PIPING



3. **Mechanical Subcooling -** refers to using a portion of liquid refrigerant, boiled to cool the remaining liquid in the liquid line. A special heat exchanger is used which cools the liquid refrigerant on one side of the exchanger with a small amount of refrigerant metered to the other side of the exchanger. The cooling refrigerant is metered by a TXV, boiled and returned to the suction line.

   The maximum amount of subcooling available is limited to approximately 1/2 of the difference between condensing and suction temperature. For example, if on a floating head system, condensing temperature is allowed to fall to within 30 F of suction, then the amount of mechanical subcooling available is about 30 x 0.50 = 15F.

   This is a positive method of subcooling under all conditions, but requires that a suction line pass close to the heat exchanger. This method of subcooling does not increases system capacity as in method 1. Mechanical Subcooling can be used alone, or with Colmac Type FC, or MS low ambient controls.

LIQUID LINE SIZING:

Liquid lines should be sized at the minimum head pressure/maximum suction pressure operating condition expected for the system. This condition produces the maximum compressor capacity and refrigerant flow rate. It is VERY important to use this condition as the liquid line design point, especially for “floating head pressure” type systems.

Liquid lines should be sized using reliable design data, and methods. “Refrigerant Line Sizing”, by D.D. Wile, ASHRAE RP185, is recommended, and can be purchased from ASHRAE, Atlanta, Georgia.

SUBCOOLER PIPING:

To maximize the benefits of subcooled liquid, be sure to follow these rules:

- size piping and valves for the maximum refrigerant flow condition anticipated, i.e.: lowest head/highest suction pressure.

- use a subcooling method that will provide required amount of subcooling at ALL operating conditions.

- ALWAYS insulate liquid lines.

- locate subcooler downstream of the receiver at the entrance to the liquid line, NOT between condenser and receiver. See Figure 7.

- use good piping practice, as can be found in ASHRAE (Systems, and Refrigeration Handbooks), and other industry publications.

LOW AMBIENT OPERATION:

As previously mentioned, condenser capacity is proportional to the difference between condensing and ambient temperature, (TD). As ambient temperature falls during winter months, so does condensing temperature (and pressure). As condensing temperature falls, refrigeration system capacity and efficiency both increase. With typical reciprocating compressors, for every 10 degree F decrease in condensing temperature:

Evaporator capacity increase = 7.5%
Total Heat of Rejection (THR) increase = 4%
Horsepower per Ton decrease = 7.5%

(Note that these are average values for an open drive compressor, with design conditions of 110 F condensing, and 24 F suction. Compressor manufacturer’s performance data should be used for determining exact efficiency increases at other conditions.)

Notice that not only does cooling capacity of the system increase with falling head pressure, but the power per ton decreases at the same time! This means the compressor will run fewer hours for the same cooling load, and use less power while it is running. So, operating a system at the lowest head pressure possible will save a substantial amount in energy costs.

HEAD PRESSURE CONTROLS:

While allowing head pressure to "float" with ambient temperatures is desirable from an energy standpoint, there are cases where some minimum head pressure must be maintained. There are two basic reasons for using Colmac low ambient head pressure controls on ACV, and ACH air-cooled condensers; 1) Maintaining condensing pressure, and 2) maintaining condensing temperature. During winter months, in colder climates, the controls will:

1. Provide enough **pressure** difference between condensing, and suction pressure to overcome system pressure drops, and to operate control valves, and/or

2. Keep the saturated condensing **temperature** high enough to provide adequate heat for heat reclaim (typical in supermarket refrigeration), and/or hot gas defrosting of evaporator coils.

Maintaining Pressure: There must be enough of a pressure difference between condensing and suction pressure to overcome the total refrigerant pressure drop throughout the system. When calculating total pressure drop, remember to use the refrigerant flow rate, and liquid temperature, at the anticipated lowest head pressure condition. Using this design point for line sizing and valve selection, will insure proper operation during low head conditions. Shown below are some typical components, which must be taken into account in the total pressure drop calculation:

	Typical Min. Pressure Drop, PSI
Liquid Line	3
Filter Dryer	2
TX Valve (use of balanced port valves is recomended)	30
Distributor	5
Evaporator Coil	3
Suction Line	1
Suction Filter	2
Suction Accumulator	2
Discharge Line	2
Condenser Coil	4
Elevation gain or loss in liquid lines	
Service Valves	3
Check Valves	2
other Control Valves (EPR, CPR)	4
	Total 68 psi

Generally speaking, the minimum allowable condensing pressure must be kept at 70 psi or more above suction pressure. TX valve manufacturers recommend that a minimum pressure drop of 30 psi across TX valves be used in the total pressure drop calculation. TX valve sizing should be checked at both the maximum, AND minimum condensing pressure conditions, for any "floating head pressure" system. Any elevation gain in liquid lines must be converted to pressure (see Table 11), and added to this 70 psi minimum pressure difference.

Colmac type LP (liquid pumping) **control** increases liquid line pressure by 12 to 15 psi. This pressure increase is used to offset system pressure drop, and is subtracted directly from the minimum condensing pressure calculated above.

Maintaining Temperature: Systems employing heat reclaim for space heating (i.e.: in supermarket refrigeration), and systems with hot gas defrosting of evaporators usually need to maintain the condensing temperature above some minimum. Typical minimum condensing temperatures for these cases are shown below:

System	**Typical Minimum Condensing Temperature**
Heat Reclaim	90 F
Hot Gas Defrost	60 F

Colmac type FC, and MS controls effectively maintain condensing temperature by cycling, and/or modulating the speed of condenser fans.

Effect of Unloading: When a system is unloaded, either by unloading compressor cylinders, or dropping parallel compressors off line, the operating condenser TD will be reduced by the same fraction. For example, if the full load design TD is 20 F, and the system is unloaded to 25% of capacity, the operating TD will become 0.25 x 20 = 5 F TD.

While condenser sizing is based on design TD, head pressure controls should be chosen on the basis of unloaded operating TD, as calculated above.

SELECTING HEAD PRESSURE CONTROLS :

To decide which Colmac head pressure control, and subcooling method (if any) is needed, use the following procedure:

Step 1. Calculate the minimum operating TD based on design TD, and the maximum amount of system unloading. See "Effect of Unloading," above.

Step 2. Calculate minimum allowable condensing pressure as suction pressure plus total system pressure drop. If Type LP liquid pumping package is used, subtract 12 psi from the total system pressure drop in this calcuation.

Step 3. Convert minimum allowable condensing pressure from Step 2, to temperature using reliable refrigerant properties tables.

Step 4. Find the correct Condensing Temperature vs. Ambient Temperature chart from Figures 8 through 13, for the Minimum Operating TD found in Step 1. Enter this chart at the Minimum Allowable Condensing Temperature from Step 3, and the minimum design (winter) ambient temperature, to determine the proper head pressure control package (no control, Type FC control, or Type MS control).

Step 5. Determine the amount of subcooling required based on liquid line pressure drop, from Table 12. Select method of subcooling from required subcooling, at the minimum operating TD. See "Subcooling" section, above.

Remember that Colmac Type LP (liquid pumping) control can be used in conjunction with any of the fan controls mentioned in Step 4.

HEAD PRESSURE CONTROLS/ SUBCOOLING SELECTION, EXAMPLE 3:

Design Conditions:

Refrigerant:	R22
Summer Design Ambient:	100°F
Winter Design Ambient:	-20°F
Design (summer) Condensing Temperature:	120°F
Design Suction Temperature:	20°F
Maximum Amount of System Unloading:	50%
Calculated Total System Pressure Drop:	80 psi
Calculated Liquid Line Pressure Drop (includes 18 ft elevation gain):	12 psi

Step 1. Design TD is calculated as:

TD = 120 - 100 = 20°F

From "Effect of Unloading" section above, the minimum operating TD will be 50% of 20°F, or 10°F. It is this operating TD that we will use for determining the proper head pressure control package, and the correct subcooling method.

Step 2. From refrigerant properties tables for R22, convert design suction temperature of 20°F to pressure of 43.3 psig.

Step 3. To allow the condensing temperature to float as low as possible, a type LP liquid pump package will be used in the system. This will reduce the total system pressure drop by 12 psi, to 68 psi.

The minimum allowable condensing pressure is calculated as suction pressure plus total system pressure drop:

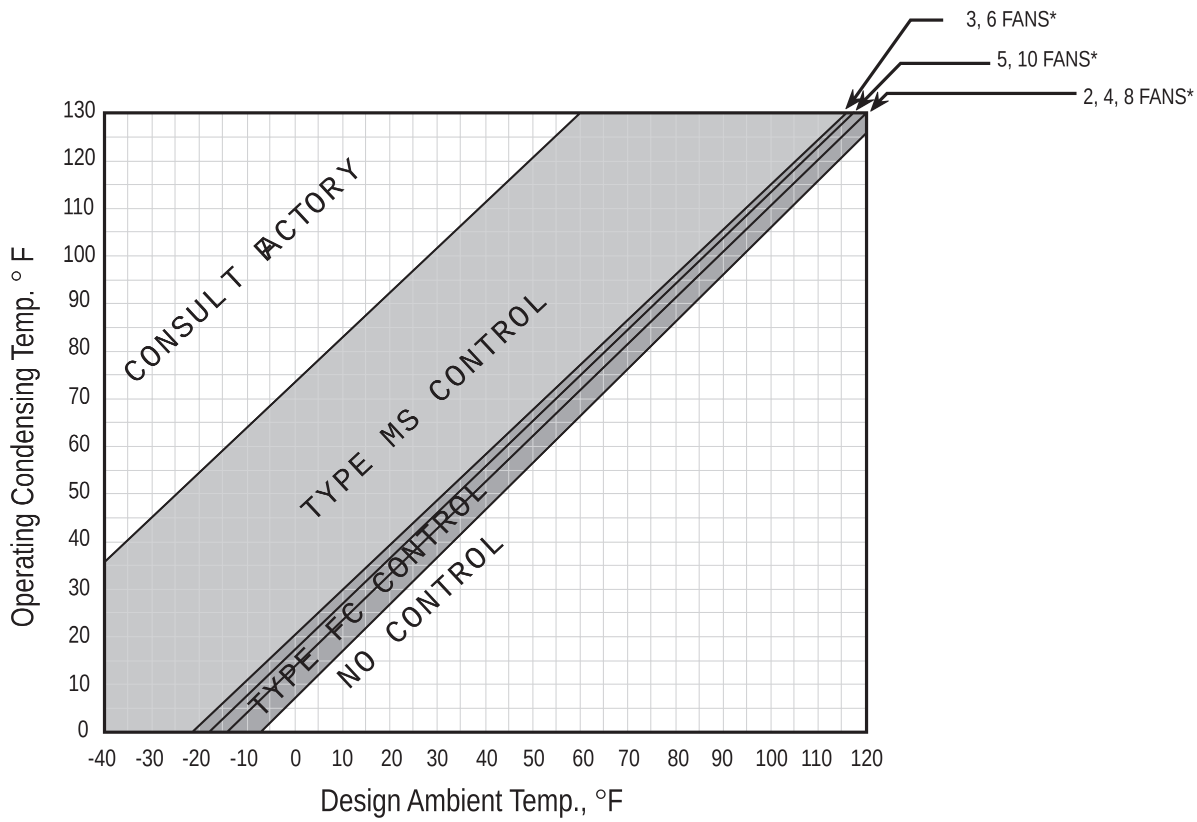
Min. condensing pressure = 43.3 + 68 = 111.3 psig

Step 4. Again, from properties tables, 111.3 psig condensing pressure converts to temperature of 65°F. This is the minimum allowable operating condensing temperature for use with Figures 8 through 13.

Step 5. To select the proper head pressure control package, enter Figure 9 (for 10°F operating TD) at -20°F Design Ambient, and 65°F Minimum Operating Condensing Temperature. The Intersection of the two lines shows type MS head pressure control is required (see Figure 9).

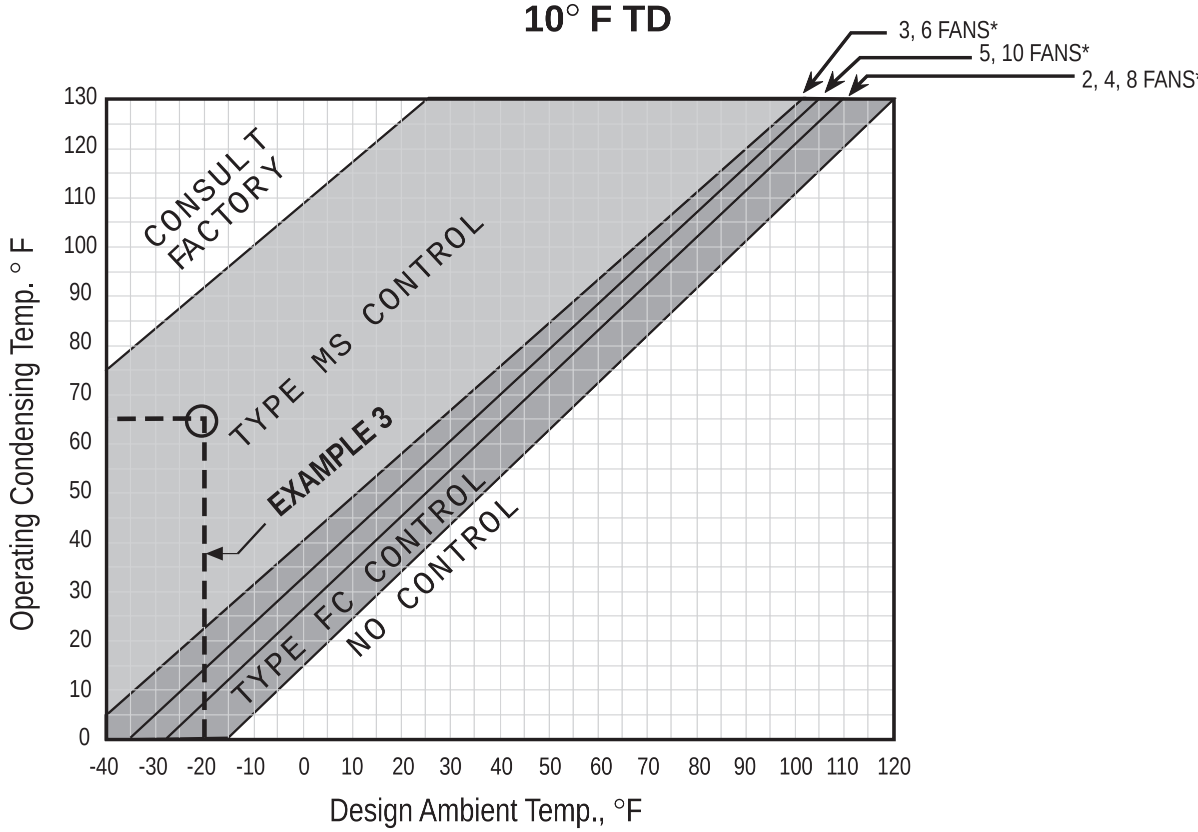
Step 6. To prevent formation of flash gas in the liquid line, enough subcooling must be done to overcome the 12 psi liquid line pressure drop. Use of "Ambient Subcooling" is not advised in this system, since Type MS head pressure control has been specified in Step 5 (see "Subcooling" section). The Type LP liquid pumping package will provide a 12 psi increase in liquid line pressure drop, which will overcome the liquid line pressure of 12 psi, and eliminate the need for additional subcooling.

FIGURE 8
CONDENSING TEMPERATURE vs. AMBIENT TEMPERATURE
5°F TD



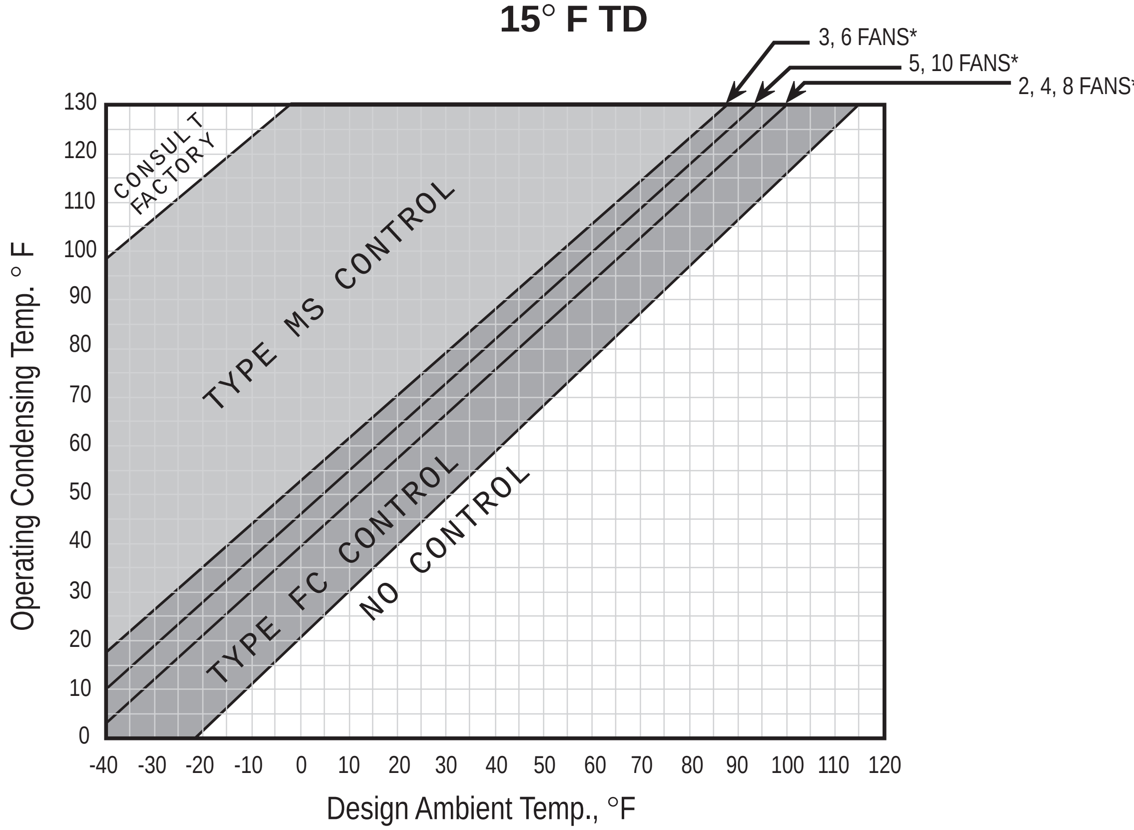
*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

FIGURE 9
CONDENSING TEMPERATURE vs. AMBIENT TEMERATURE
10° F TD



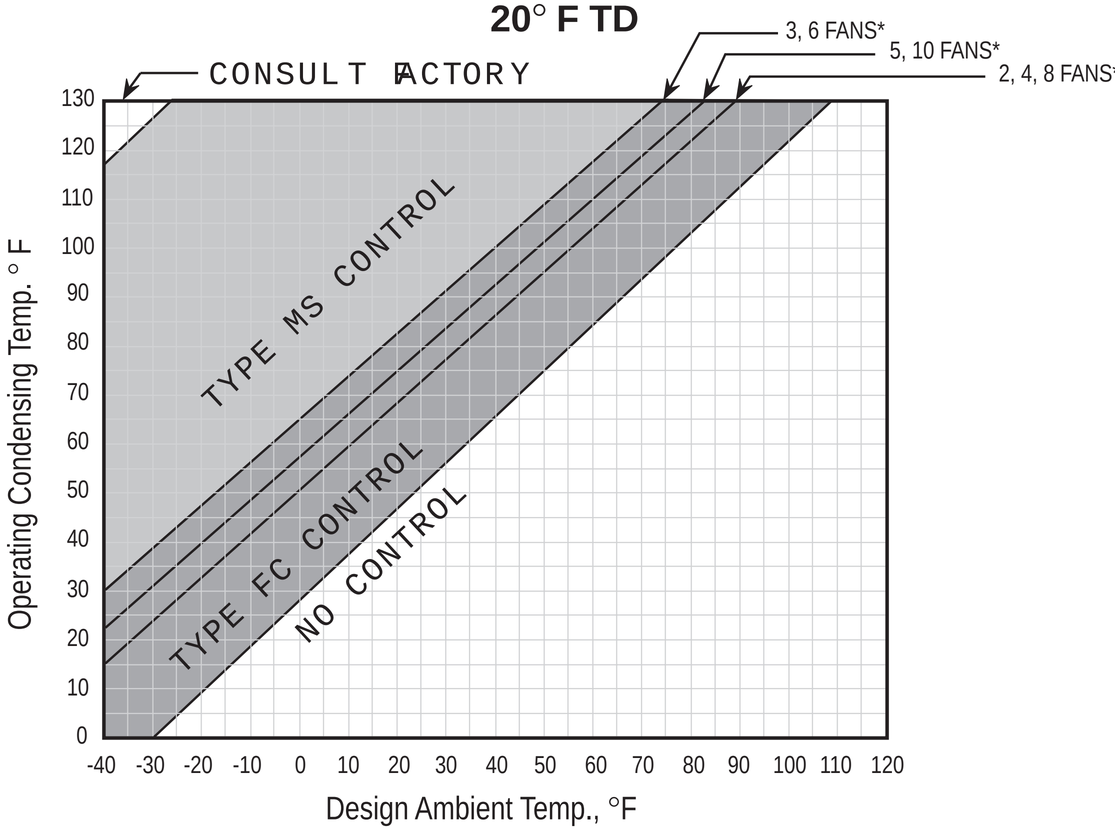
*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

FIGURE 10
CONDENSING TEMPERATURE vs. AMBIENT TEMERATURE
15° F TD



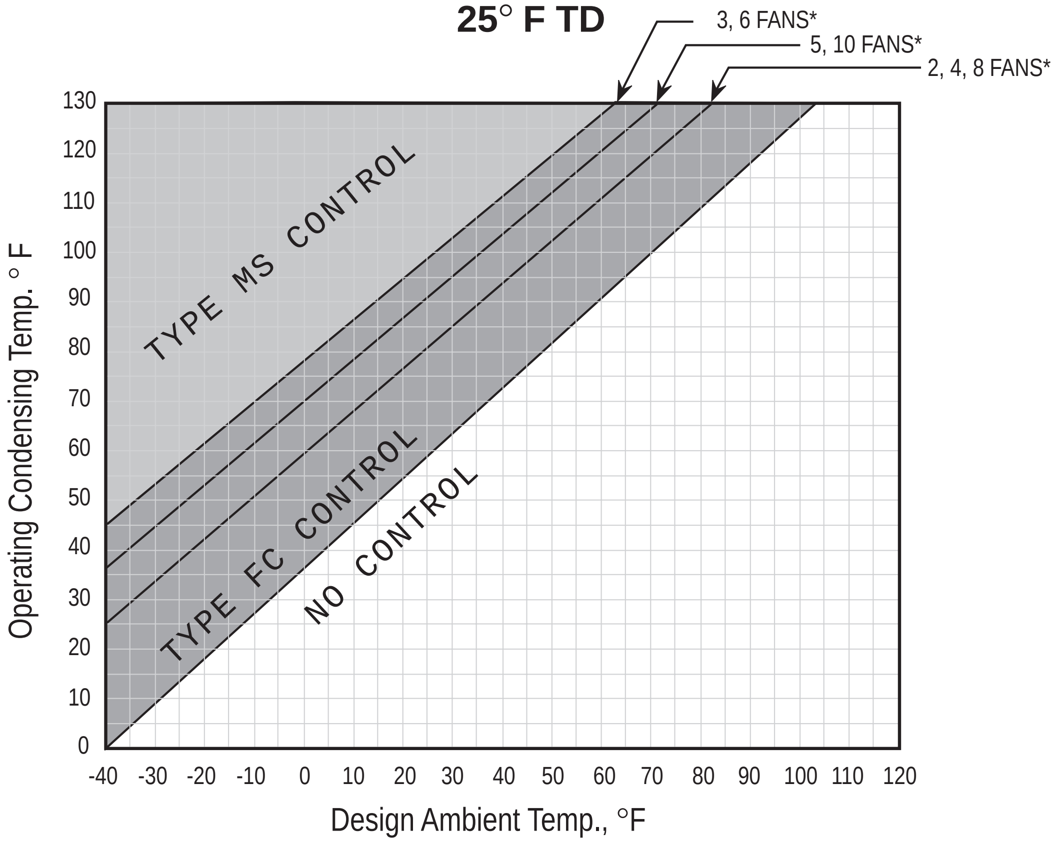
*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

FIGURE 11
CONDENSING TEMPERATURE vs. AMBIENT TEMERATURE
20° F TD



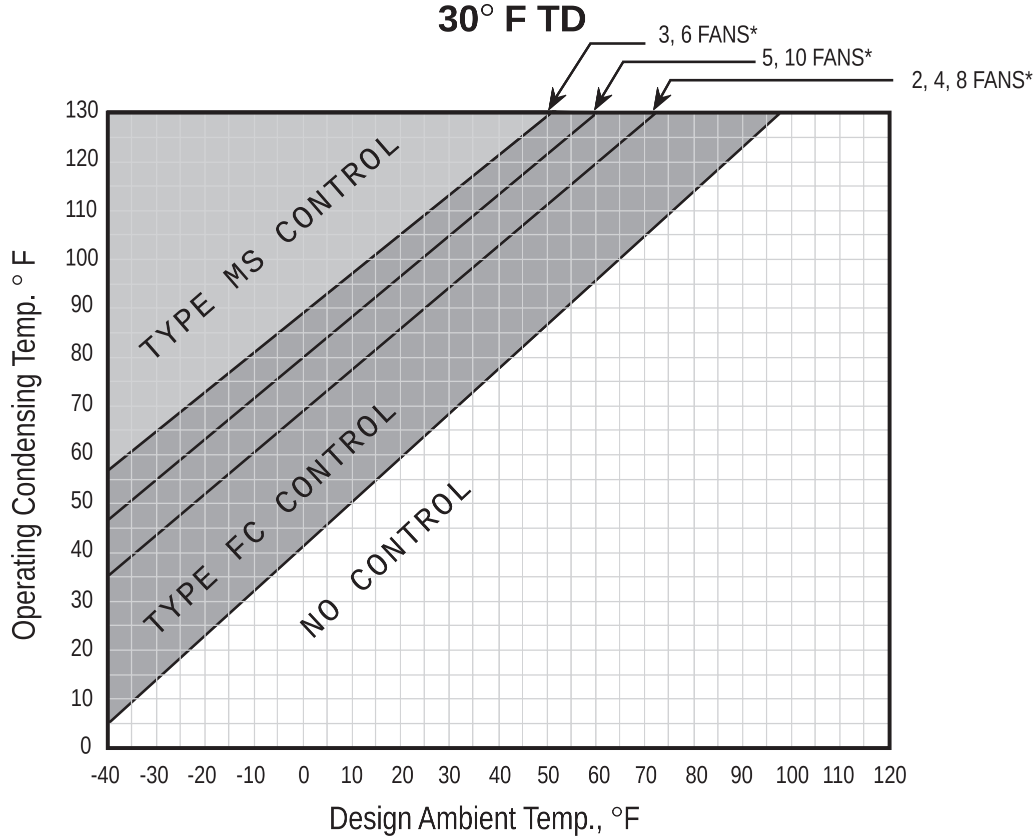
*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

FIGURE 12
CONDENSING TEMPERATURE vs. AMBIENT TEMERATURE
25° F TD



*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

FIGURE 13
CONDENSING TEMPERATURE vs. AMBIENT TEMERATURE
30° F TD



*Note that Colmac Type FC control is not available for 1 Fan models (use Type MS, and/or Type LP controls).

Multi-System Head Pressure Control: Colmac ACV/ACH condensers with up to 10 separate systems can be controlled by Type FC, and MS head pressure controls. Condensing temperature for each system is sensed simultaneously, and the control responds to the system with highest condensing temperature.

REFRIGERANT CHARGE:

Because Colmac Type FC, MS, and LP controls do not require flooding of the condenser for head pressure control, refrigerant charge remains relatively small. Internal volume and operating charge for ACV/ACH condensers is shown in Table 2.

Receiver Sizing: A liquid receiver is required on all subcooled systems, and on systems with a liquid solenoid/pump down feature. The receiver must be made large enough to accommodate the liquid present in liquid lines, and in the evaporator. Calculate liquid line charge inventory as: Internal Volume of the lines times Liquid Density, in lbs. Direct expansion evaporator charge inventory can be estimated as: Internal Volume of the evaporator times Liquid Density times 0.30, in lbs.

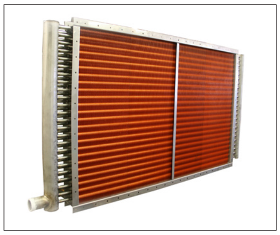
Colmac ACV/ACH condensers can be supplied with a factory mounted, and piped receiver as an option. Specify refrigerant, and total receiver charge in pounds when ordering.

PIPING:

When designing system piping remember to size for the the lowest head pressure condition anticipated. Insulate liquid as well as suction lines. Use good piping practices as described in the ASHRAE Refrigeration Handbook, and other industry publications. See Figure 7, and “Subcooler Piping”, above for specific information about subcoolers.

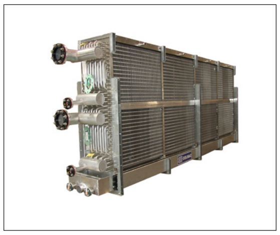
COLMAC COIL
Manufacturing Inc.

Other Quality Products From Colmac Coil


Heating and Cooling Coils


Heat Pipes for Heat Recovery


Dry Coolers for Glycol or Gas Cooling


Custom Evaporators & Baudelot Coolers


Air Cooled Condensers

CE(PED) Certification, ASME Sec. VIII, Canadian Registration Number, UL508, Canadian Standards Association

CE U CRN UL CSA

Visit www.colmaccoil.com for more information and resources:

Product Information
Product Literature
Sales Rep Locator
Sales Rep e-Library
Product Videos

North American Headquarters
Colmac Coil Manufacturing, Inc.
370 N. Lincoln St. | P.O. Box 571
Colville, WA 99114 | USA
+1.509.684.2595 | +1.800.845.6778

Midwest US Manufacturing
Colmac Coil Midwest
350 Baltimore Dr. | Paxton, IL 60957 | USA

"The Heat Transfer Experts"