CLIMA VAC

AIR CAPSULE

GMECHGROUP

CLIMAVAC AIR CAPSULE

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CHAPTER 1

Internal Loads - Infiltration - Ventilation

Cooling load Estimations Rule Of Thumb

Space	General Offices	Perimeter Offices	Interior Offices
Total Load (m^2/TR)	27 - 37	20-25	27-32
Total Load (Ft^2/TR)	300 - 400	225 - 275	300 - 350
Total Heat (Btuh/ft^2)	30 - 40	30 - 40	30 - 40
Sensible Heat (Btuh/ft^2)	25 - 28	25 - 28	25 - 28
RSHF	0.75 - 0.93	0.75 - 0.93	0.75 - 0.93
Air Change Rate	4.0 - 10	4.0 - 10	4.0 - 10
Space	**Restaurants**	**Cocktail Lounge / Bar**	**Patient Rooms**
Total Load (m^2/TR)	9.5 - 24	14 - 18	23 - 27
Total Load (Ft^2/TR)	100 - 250	150 - 200	250 - 300
Total Heat (Btuh/ft^2)	28 - 120	60 - 80	40 - 48
Sensible Heat (Btuh/ft^2)	21 - 62	27 - 40	32 - 46
RSHF	0.65 - 0.8	0.65 - 0.8	0.75 - 0.85
Air Change Rate	7.5 - 12	15 - 20	4.5 - 25
Space	**Dining Halls**	**Libraries / Museums**	**Retail, Departments Store**
Total Load (m^2/TR)	9.5 - 24	25 - 32	18 - 27
Total Load (Ft^2/TR)	100 - 250	250 - 350	200 - 300
Total Heat (Btuh/ft^2)	48 - 120	34 - 48	40 - 60
Sensible Heat (Btuh/ft^2)	21 - 62	22 - 32	32 - 43
RSHF	0.65 - 0.8	0.8 - 0.9	0.65 - 0.9
Air Change Rate	12.5 - 15	8.0 - 12	6.0 - 10
Space	**Theaters**	**Churches**	
Total Load (TR/Seat)	0.05 - 0.07	0.04 - 0.06	
Total Heat (Btuh/Seat)	600 - 840	480 - 720	
Sensible Heat (Btuh/Seat)	325 - 385	260 - 330	
RSHF	0.65 - 0.75	0.65 - 0.75	
Air Change Rate	8.0 - 15	8.0 - 15	

"Banks/ Court Houses"	"Town Hall/ Municipal Building"	"Police Station /FireStation"	Computer Rooms
18-23	18-23	23-32	4.5 - 14
200 - 250	200 - 250	250 - 350	50 - 150
48 - 60	48 - 60	34-48	80 - 240
28 - 38	28 - 38	25-35	64 - 228
0.75 - 0.9	0.75 - 0.9	0.75 - 0.9	0.8 - 0.95
4.0 - 10	4.0 - 10	4.0 - 10	15 - 20
"Dental Centers/Clinics"	Appatments	Hotel Public Spaces	School Classrooms
23 - 27	30 - 40	24 - 27	20 - 25
250 - 300	350 - 450	250 - 300	225 - 275
40 - 48	27 - 34	40 - 48	43- 53
32 - 46	22 - 30	32 - 46	25 - 42
0.75 - 0.85	0.8 - 0.95	0.75 - 0.85	0.65 - 0.8
4.5 - 25			4.0 - 12
Dress & JewelryStore	SuperMarkets	Malls	Jails
16 - 20	23 - 32	13 - 32	32 - 41
175 - 225	250 - 350	150 - 350	350 - 450
53 - 69	34 - 48	34 - 80	27 - 34
23 - 54	25 - 40	25 - 67	22- 30
0.65 - 0.9	0.65 - 0.85	0.65 - 0.85	0.8 - 0.95
6.0 - 10	6.0 - 10	6.0 - 10	
	Space	Bowling Alleys	
	Total Load (TR/Alley)	1.5 - 2.5	
		1.5 - 2.5	
		1.5 - 2.5	
		1.5 - 2.5	
	Air Change Rate	9.0 - 15	

Important Note:
Each Supplier Recommends Max Area for each Equipment Capacity So this Must Be taken into account Before Selecting the Equipment Capacity.

Here are recommended max. Area for split concealed units of a well known brand

Model Number	Fan Coil Unite (Indoor)	Dimensions(LxHxW)	appropriate area m²
QDM - 12	HEAT PUMP	70*21*63.5	UP TO 15
QDM - 18	HEAT PUMP	92*21*63.5	UP TO 20
QDM - 24	HEAT PUMP	92*27*63.5	UP TO 28
QDM - 30	HEAT PUMP	114*27*77.5	UP TO 38
QDM - 36	HEAT PUMP	114*27*77.5	UP TO 45
QDM - 42	HEAT PUMP	120*30*86.5	UP TO 50
QDM - 48	HEAT PUMP	120*30*86.5	UP TO 55
QDM - 60	HEAT PUMP	120*30*86.5	UP TO 60

Internal Loads Calculations

1-Electric Motors

Motor Horsepower	The Location of Motor and Driven Equipment with Respect to a Conditioned Space or Airstream		
	Motor In, Driven Equipment In Btu/hr.	Motor Out, Driven Equipment In Btu/hr.	Motor In, Driven Equipment Out Btu/hr.
1/20	360	130	240
1/12	580	200	380
1/8	900	320	590
1/6	1,160	400	760
1/4	1,180	640	540
1/3	1,500	840	660
1/2	2,120	1,270	850
3/4	2,650	1,900	740
1	3,390	2,550	850
1-1/2	4,960	3,820	1,140
2	6,440	5,090	1,350
3	9,430	7,640	1,790
5	15,500	12,700	2,790
7-1/2	22,700	19,100	3,640
10	29,900	24,500	4,490
15	44,400	38,200	6,210
20	58,500	50,900	7,610
25	72,300	63,600	8,680
30	85,700	76,300	9,440
40	114,000	102,000	12,600
50	143,000	127,000	15,700
60	172,000	153,000	18,900
75	212,000	191,000	21,200
100	283,000	255,000	28,300
125	353,000	318,000	35,300
150	420,000	382,000	37,800
200	569,000	509,000	50,300
250	699,000	636,000	62,900

Common Space Types*	LPD, W/m²
Atrium	
≤12.2 m high	1.1/m total height
>12.2 m high	4.3 + 0.7/m total height
Audience Seating Area	
In auditorium	6.8
In convention center	8.9
In gymnasium	7.1
In motion picture theater	12.3
In penitentiary	3.1
In performing arts theater	26.2
In religious building	16.5
In sports arena	4.7
All other audience seating areas	4.7
Banking Activity Area	11.9
Breakroom (*See* Lounge/Breakroom)	
Classroom/Lecture Hall/Training Room	
In penitentiary	14.5
All other classrooms/lecture halls/ training rooms	13.4
Conference/Meeting/Multipurpose Room	13.3
Confinement Cells	8.8
Copy/Print Room	7.8
Corridor[b]	
In facility for visually impaired (and not used primarily by staff)[c]	9.9
In hospital	10.7
In manufacturing facility	4.4
All other corridors	7.1
Courtroom	18.6
Computer Room	18.4
Dining Area	
In penitentiary	10.4
In facility for visually impaired (and not used primarily by staff)[c]	28.5 W/m²
In bar/lounge or leisure dining	11.6
In cafeteria or fast food dining	7.0
In family dining	9.6
All other dining areas	7.0
Electrical/Mechanical Room[f]	4.6
Emergency Vehicle Garage	6.1
Food Preparation Area	13.1
Guest Room	9.8
Laboratory	
In or as classroom	15.5
All other laboratories	19.5
Laundry/Washing Area	6.5

Common Space Types[a]	LPD, W/m²
Loading Dock, Interior	5.1
Lobby	
In facility for the visually impaired (and not used primarily by staff)[c]	19.4
For elevator	7.0
In hotel	11.5
In motion picture theater	6.4
In performing arts theater	21.6
All other lobbies	9.7
Locker Room	8.1
Lounge/Breakroom	
In health care facility	10.0
All other lounges/breakrooms	7.9
Office	
Enclosed	12.0
Open plan	10.6
Parking Area, Interior	2.1
Pharmacy Area	18.1
Restroom	
In facility for the visually impaired (and not used primarily by staff)[c]	13.1
All other restrooms	10.6
Sales Area[d]	15.5
Seating Area, General	5.9
Stairway	
Space containing stairway determines LPD and control requirements for stairway.	
Stairwell	7.4
Storage Room	
<4.65 m²	13.3
All other storage rooms	6.8
Vehicular Maintenance Area	7.3
Workshop	17.2

Building-Specific Space Types*	LPD, W/m²
Facility for Visually Impaired[c]	
In chapel (used primarily by residents)	23.8
In recreation room/common living room (and not used primarily by staff)	26.0
Automotive (*See* Vehicular Maintenance Area)	
Convention Center: Exhibit Space	15.7
Dormitory/Living Quarters	4.2
Fire Station: Sleeping Quarters	0.22
Gymnasium/Fitness Center	
In exercise area	7.8
In playing area	13.0

Building-Specific Space Types*	LPD, W/m²
Health Care Facility	
In exam/treatment room	18.0
In imaging room	16.3
In medical supply room	7.96
In nursery	9.5
In nurses' station	7.6
In operating room	26.8
In patient room	6.7
In physical therapy room	9.9
In recovery room	12.4
Library	
In reading area	11.5
In stacks	18.4
Manufacturing Facility	
In detailed manufacturing area	13.9
In equipment room	8.0
In extra-high-bay area (15.2 m floor-to-ceiling height)	11.3
In high-bay area (7.6 to 15.2 m floor-to-ceiling height)	13.3
In low-bay area (<7.6 m floor-to-ceiling height)	12.9
Museum	
In general exhibition area	11.4
In restoration room	11.0
Performing Arts Theater, Dressing Room	6.6
Post Office, Sorting Area	10.2
Religious Buildings	
In fellowship hall	6.9
In worship/pulpit/choir area	16.5
Retail Facilities	
In dressing/fitting room	7.7
In mall concourse	11.9
Sports Arena, Playing Area	
For Class I facility	39.7
For Class II facility	25.9
For Class III facility	19.4
For Class IV facility	13.0
Transportation Facility	
In baggage/carousel area	5.7
In an airport concourse	3.9
At a terminal ticket counter	8.7
Warehouse—Storage Area	
For medium to bulky, palletized items	6.2
For smaller, hand-carried items[e]	10.2

Source: ASHRAE *Standard* 90.1-2013.

[a]In cases where both a common space type and a building-specific type are listed, the building-specific space type applies.

[b]In corridors, extra lighting power density allowance is granted when corridor width is <2.4 m and is not based on room/corridor ratio (RCR).

[c]A facility for the visually impaired one that can be documented as being designed to comply with light levels in ANSI/IES RP-28 and is (or will be) licensed by local/state authorities for either senior long-term care, adult daycare, senior support, and/or people with special visual needs.

[d]For accent lighting, see section 9.6.2(b) of ASHRAE *Standard* 90.1-2013.

[e]Sometimes called a picking area.

[f]An additional 5.7 W/m² is allowed *only* if this additional lighting is controlled separately from the base allowance of 4.5 W/m².

3-People Loads (ASHRAE Fund. 2021ED)

Degree of Activity	Location	Total Heat, W: Adult Male	Total Heat, W: Adjusted, M/F[a]	Sensible Heat, W	Latent Heat, W	% Sensible Heat that is Radiant[b]: Low V	% Sensible Heat that is Radiant[b]: High V
Seated at theater	Theater	115	105	70	35	60	27
Seated, very light work	Offices, hotels, apartments	130	115	70	45		
Moderately active office work	Offices, hotels, apartments	140	130	75	55		
Standing, light work; walking	Department store; retail store	160	130	75	55	58	38
Walking, standing	Drug store, bank	160	145	75	70		
Sedentary work	Restaurant[c]	145	160	80	80		
Light bench work	Factory	235	220	80	140		
Moderate dancing	Dance hall	265	250	90	160	49	35
Walking 4.8 km/h; light machine work	Factory	295	295	110	185		
Bowling[d]	Bowling alley	440	425	170	255		
Heavy work	Factory	440	425	170	255	54	19
Heavy machine work; lifting	Factory	470	470	185	285		
Athletics	Gymnasium	585	525	210	315		

Notes:
1. Tabulated values are based on 24°C room dry-bulb temperature. For 27°C room dry bulb, total heat remains the same, but sensible heat values should be decreased by approximately 20%, and latent heat values increased accordingly.
2. Also see Table 4, Chapter 9, for additional rates of metabolic heat generation.
3. All values are rounded to nearest 5 W.

[a] Adjusted heat gain is based on normal percentage of men, women, and children for the application listed, and assumes that gain from an adult female is 85% of that for an adult male, and gain from a child is 75% of that for an adult male.
[b] Values approximated from data in Table 6, Chapter 9, where V is air velocity with limits shown in that table.
[c] Adjusted heat gain includes 18 W for food per individual (9 W sensible and 9 W latent).
[d] Figure one person per alley actually bowling, and all others as sitting (117 W) or standing or walking slowly (231 W).

4-Medical Equipment (ASHRAE Fund. 2021ED)

Equipment	Nameplate, W	Peak, W	Average, W
Anesthesia system	250	177	166
Blanket warmer	500	504	221
Blood pressure meter	180	33	29
Blood warmer	360	204	114
ECG/RESP	1440	54	50
Electrosurgery	1000	147	109
Endoscope	1688	605	596
Harmonical scalpel	230	60	59
Hysteroscopic pump	180	35	34
Laser sonics	1200	256	229
Optical microscope	330	65	63
Pulse oximeter	72	21	20
Stress treadmill	N/A	198	173
Ultrasound system	1800	1063	1050
Vacuum suction	621	337	302
X-ray system	968		82
	1725	534	480
	2070		18

Source: Hosni et al. (1999).

5-Lab. Equipment (ASHRAE Fund. 2021ED)

Equipment	Nameplate, W	Peak, W	Average, W
Analytical balance	7	7	7
Centrifuge	138	89	87
	288	136	132
	5500	1176	730
Electrochemical analyzer	50	45	44
	100	85	84
Flame photometer	180	107	105
Fluorescent microscope	150	144	143
	200	205	178
Function generator	58	29	29
Incubator	515	461	451
	600	479	264
	3125	1335	1222
Orbital shaker	100	16	16
Oscilloscope	72	38	38
	345	99	97
Rotary evaporator	75	74	73
	94	29	28
Spectronics	36	31	31
Spectrophotometer	575	106	104
	200	122	121
	N/A	127	125
Spectro fluorometer	340	405	395
Thermocycler	1840	965	641
	N/A	233	198
Tissue culture	475	132	46
	2346	1178	1146

Source: Hosni et al. (1999).

6-Electric Appliances (Unhooded - During Cooking)

Table 5B Recommended Rates of Radiant and Convective Heat Gain from Unhooded Electric Appliances during Cooking Conditions

Appliance	Energy Rate, W: Rated	Energy Rate, W: Cooking	Rate of Heat Gain, W: Sensible Radiant	Rate of Heat Gain, W: Sensible Convective	Rate of Heat Gain, W: Latent	Rate of Heat Gain, W: Total	Usage Factor F_U	Radiation Factor F_R
Cheesemelter	2400	2714	443	1094	599	2136	1.13	0.16
Egg cooker	2380	1191	65	369	630	1065	0.50	0.05
Fryer, countertop, open deep fryer	4600	3818	202	492	1629	2323	0.83	0.05
Griddle, countertop	8000	3280	848	631	1277	2757	0.41	0.26
Hot dog roller	1600	1577	267	611	679	1556	0.99	0.17
Hot plate, single burner	1100	985	313	627	44	985	0.90	0.32
Induction hob, countertop	5000	653	0	318	335	653	0.13	0.00
Oven, conveyor	5000	4292	718	2454	193	3365	0.86	0.17
Microwave	1700	2363	0	934	995	1929	1.39	0.00
Rapid cook	5700	2310	96	1234	771	2102	0.41	0.04
Panini grill	1800	1374	195	718	150	1062	0.76	0.14
Popcorn popper	850	576	28	236	192	457	0.68	0.05
Rice cooker	1550	1159	14	95	44	153	0.75	0.01
Soup warmer	800	842	0	85	716	801	1.05	0.00
Steamer (bun)	1500	791	32	240	511	783	0.53	0.04
Steamer, countertop	8300	7731	0	499	6934	7433	0.93	0.00
Toaster, conveyor	1745	1705	358	974	373	1705	0.98	0.21
Vertical	2600	1841	180	715	322	1218	0.71	0.10
Tortilla grill	2200	2194	254	1267	673	2194	1.00	0.12
Waffle maker	2700	1180	60	357	559	975	0.44	0.05

Source: ASHRAE research project RP-1631 (Zhang et al. 2015).

7-Electric Appliances (hooded - During Cooking)

Appliance	Energy Rate, W		Rate of Heat Gain, W	Usage Factor	Radiation
	Rated	Standby	Sensible Radiant	F_U	Factor F_R
Broiler: underfired 900 mm	10 814	9 056	3165	0.84	0.35
Cheesemelter*	3 605	3 488	1348	0.97	0.39
Fryer, kettle	29 014	528	147	0.02	0.28
Open deep-fat, 1-vat	14 008	821	293	0.06	0.36
Pressure	13 511	791	147	0.06	0.19
Griddle, double-sided 900 mm (clamshell down)*	21 218	2 022	410	0.10	0.20
(Clamshell up)*	21 218	3 370	1055	0.16	0.31
Flat 900 mm	17 115	3 370	1319	0.20	0.39
Small 900 mm*	8 997	1 788	791	0.20	0.44
Induction cooktop*	21 013	0	0	0.00	0.00
Induction wok*	3 488	0	0	0.00	0.00
Oven, combi: combi-mode*	16 411	1 612	234	0.10	0.15
Combi: convection mode	16 412	1 612	410	0.10	0.25
Oven, convection full-size	12 103	1 964	440	0.16	0.22
Convection half-size*	5 510	1 084	147	0.20	0.14
Pasta cooker*	22 010	2 491	0	0.11	0.00
Range top, top off/oven on*	4 865	1 172	293	0.24	0.25
3 elements on/oven off	15 005	4 513	1846	0.30	0.41
6 elements on/oven off	15 005	9 730	4074	0.65	0.42
6 elements on/oven on	19 870	10 668	4250	0.54	0.40
Range, hot-top	15 826	15 035	3458	0.95	0.23
Rotisserie*	11 107	4 044	1319	0.36	0.33
Salamander*	7 004	6 829	2051	0.97	0.30
Steam kettle, large (225 L), simmer lid down*	32 414	762	29	0.02	0.04
small (150 L), simmer lid down*	21 599	528	88	0.02	0.17
Steamer, compartment, atmospheric*	9 789	4 484	59	0.46	0.01
Tilting skillet/braising pan	9 642	1 553	0	0.16	0.00

*Items with an asterisk appear only in Swierczyna et al. (2009); all others appear in both Swierczyna et al. (2008) and (2009).

Infiltration Rule of thumbs

Heating Infiltration (15-mph wind)

A.Air Change Rate Method
1.Range 0 to 10 AC/hr.
2.Commercial buildings:
a.1.0 AC/hr. one exterior wall
b.1.5 AC/hr. two exterior walls
c.2.0 AC/hr. three or four exterior walls
3.Vestibules 3.0 AC/hr.

B.CFM/sq.ft. of Wall Method
1. Range 0 to 1.0 CFM/sq.f
2Tight buildings 0.1 CFM/sq.ft.
3.Average buildings 0.3 CFM/sq.ft.
4.Leaky building 0.6 CFM/sq.ft.

C.Crack Method
1.Range 0.12 to 2.8 CFM/ft. of crack
2.Average 1.0 CFM/ft. of crack

Cooling Infiltration (7.5-mph wind)

A.Cooling load infiltration is generally ignored unless close tolerances in tempera- true and humidity control are required.

B.Cooling infiltration values are generally taken as 1/2 of the values listed earlier for heating infiltration.

Ventilation Calculations

(According to Ashrae 62.1 2019ed.)

Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone (Vbz) of the occupiable space or spaces in a ventilation zone shall be not less than thevalue determined in accordance With this Equation.

Vbz = Rp × Pz + Ra × Az (6-1)

where

Az = zone floor area, the net occupiable floor area of the ventilation zone, ft2 (m2)

Pz = zone population, the number of people in the ventilation zone during use

Rp = outdoor airflow rate required per person as determined from the Following Table.

Ra = outdoor airflow rate required per unit area as determined from Following Table.**Example:**

Assume you Are Designing the Ventilation System of a GYM with 1000 ft2 Area and is Designed to have 15 Persons Exercising at the Same Time.

From the Following table in the GYM Row, you can Get that

Rp = 20 CFM / Person

Ra = 0.18 CFM / Ft2

Minimum Fresh Air Required

= 20 x 15 + 0.18 x 1000 = 480 CFM

Important Notes:

•Whenever You Design Any Zone and you Have Direct Exhaust Due to (Toilets, Lockers Specific Equipment, Exfiltration, etc.) this Exhaust Air must be taken into Account when Calculating Fresh Air Required for the Zone.

•Zones where emissions are expected from stored hazardous materials are not typical for any listed occupancy category.

•Dry ice, theatrical smoke, and smoke-producing activities are not typical for any listed occupancy categories

Min. Ventilation Rates

(According to Ashrae 62.1 2019ed.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values Occupant Density	Air Class	OS (6.2.6.1.4)
	cfm/ person	L/s· person	cfm/ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2		
Animal Facilities							
Animal exam room (veterinary office)	10	5	0.12	0.6	20	2	
Animal imaging (MRI/CT/PET)	10	5	0.18	0.9	20	3	
Animal operating rooms	10	5	0.18	0.9	20	3	
Animal postoperative recovery room	10	5	0.18	0.9	20	3	
Animal preparation rooms	10	5	0.18	0.9	20	3	
Animal procedure room	10	5	0.18	0.9	20	3	
Animal surgery scrub	10	5	0.18	0.9	20	3	
Large-animal holding room	10	5	0.18	0.9	20	3	
Necropsy	10	5	0.18	0.9	20	3	
Small-animal-cage room (static cages)	10	5	0.18	0.9	20	3	
Small-animal-cage room (ventilated cages)	10	5	0.18	0.9	20	3	
Correctional Facilities							
Booking/waiting	7.5	3.8	0.06	0.3	50	2	
Cell	5	2.5	0.12	0.6	25	2	
Dayroom	5	2.5	0.06	0.3	30	1	
Guard stations	5	2.5	0.06	0.3	15	1	
Educational Facilities							
Art classroom	10	5	0.18	0.9	20	2	
Classrooms (ages 5 to 8)	10	5	0.12	0.6	25	1	
Classrooms (age 9 plus)	10	5	0.12	0.6	35	1	
Computer lab	10	5	0.12	0.6	25	1	
Daycare sickroom	10	5	0.18	0.9	25	3	
Daycare (through age 4)	10	5	0.18	0.9	25	2	
Lecture classroom	7.5	3.8	0.06	0.3	65	1	✓
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3	150	1	✓
Libraries	5	2.5	0.12	0.6	10		
Media center	10	5	0.12	0.6	25	1	
Multiuse assembly	7.5	3.8	0.06	0.3	100	1	✓
Music/theater/dance	10	5	0.06	0.3	35	1	✓
Science laboratories	10	5	0.18	0.9	25	2	

a. Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.

b. The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.

Informative Note: These rates are intended only for outpatient dental clinics where the amount of nitrous oxide is limited. They are not intended for dental operatories in institutional buildings where nitrous oxide is piped.

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values Occupant Density	Air Class	OS (6.2.6.1.4)
	cfm/ person	L/s· person	cfm/ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2		
Educational Facilities (continued)							
University/college laboratories	10	5	0.18	0.9	25	2	
Wood/metal shop	10	5	0.18	0.9	20	2	
Food and Beverage Service							
Bars, cocktail lounges	7.5	3.8	0.18	0.9	100	2	
Cafeteria/fast-food dining	7.5	3.8	0.18	0.9	100	2	
Kitchen (cooking)	7.5	3.8	0.12	0.6	20	2	
Restaurant dining rooms	7.5	3.8	0.18	0.9	70	2	
Food and Beverage Service, General							
Break rooms	5	2.5	0.06	0.3	25	1	✓
Coffee stations	5	2.5	0.06	0.3	20	1	✓
Conference/meeting	5	2.5	0.06	0.3	50	1	✓
Corridors	—	—	0.06	0.3	—	1	✓
Occupiable storage rooms for liquids or gels	5	2.5	0.12	0.6	2	2	
Hotels, Motels, Resorts, Dormitories							
Barracks sleeping areas	5	2.5	0.06	0.3	20	1	✓
Bedroom/living room	5	2.5	0.06	0.3	10	1	✓
Laundry rooms, central	5	2.5	0.12	0.6	10	2	
Laundry rooms within dwelling units	5	2.5	0.12	0.6	10	1	
Lobbies/prefunction	7.5	3.8	0.06	0.3	30	1	✓
Multipurpose assembly	5	2.5	0.06	0.3	120	1	✓
Miscellaneous Spaces							
Banks or bank lobbies	7.5	3.8	0.06	0.3	15	1	✓
Bank vaults/safe deposit	5	2.5	0.06	0.3	5	2	✓
Computer (not printing)	5	2.5	0.06	0.3	4	1	✓
Freezer and refrigerated spaces (<50°F [10°C])	10	5	0	0	0	2	
Manufacturing where hazardous materials are not used	10	5.0	0.18	0.9	7	2	
Manufacturing where hazardous materials are used (excludes heavy industrial and chemical processes)	10	5.0	0.18	0.9	7	3	
Pharmacy (prep. area)	5	2.5	0.18	0.9	10	2	
Photo studios	5	2.5	0.12	0.6	10	1	
Shipping/receiving	10	5	0.12	0.6	2	2	

a. Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.

b. The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default Values Occupant Density	Air Class	OS (6.2.6.1.4)
	cfm/ person	L/s· person	cfm/ft^2	L/s·m^2	#/1000 ft^2 or #/100 m^2		
Miscellaneous Spaces (continued)							
Sorting, packing, light assembly	7.5	3.8	0.12	0.6	7	2	
Telephone closets	—	—	0.00	0.0	—	1	
Transportation waiting	7.5	3.8	0.06	0.3	100	1	✓
Warehouses	10	5	0.06	0.3	—	2	
Office Buildings							
Breakrooms	5	2.5	0.12	0.6	50	1	
Main entry lobbies	5	2.5	0.06	0.3	10	1	✓
Occupiable storage rooms for dry materials	5	2.5	0.06	0.3	2	1	
Office space	5	2.5	0.06	0.3	5	1	✓
Reception areas	5	2.5	0.06	0.3	30	1	✓
Telephone/data entry	5	2.5	0.06	0.3	60	1	✓
Outpatient Health Care Facilities [a,b]							
Birthing room	10	5	0.18	0.9	15	2	
Class 1 imaging rooms	5	2.5	0.12	0.6	5	1	
Dental operatory	10	5	0.18	0.9	20	1	
General examination room	7.5	3.8	0.12	0.6	20	1	
Other dental treatment areas	5	2.5	0.06	0.3	5	1	
Physical therapy exercise area	20	10	0.18	0.9	7	2	
Physical therapy individual room	10	5	0.06	0.3	20	1	
Physical therapeutic pool area	—	—	0.48	2.4	—	2	
Prosthetics and orthotics room	10	5	0.18	0.9	20	1	
Psychiatric consultation room	5	2.5	0.06	0.3	20	1	
Psychiatric examination room	5	2.5	0.06	0.3	20	1	
Psychiatric group room	5	2.5	0.06	0.3	50	1	
Psychiatric seclusion room	10	5	0.06	0.3	5	1	
Speech therapy room	5	2.5	0.06	0.3	20	1	
Urgent care examination room	7.5	3.8	0.12	0.6	20	1	
Urgent care observation room	5	2.5	0.06	0.3	20	1	
Urgent care treatment room	7.5	3.8	0.18	0.9	20	1	
Urgent care triage room	10	5	0.18	0.9	20	1	

a. Outpatient facilities to which the rates apply are freestanding birth centers, urgent care centers, neighborhood clinics and physicians offices, Class 1 imaging facilities, outpatient psychiatric facilities, outpatient rehabilitation facilities, and outpatient dental facilities.

b. The requirements of this table provide for acceptable IAQ. The requirements of this table do not address the airborne transmission of airborne viruses, bacteria, and other infectious contagions.

Informative Note: These rates are intended only for outpatient dental clinics where the amount of nitrous oxide is limited. They are not intended for dental operatories in institutional buildings where nitrous oxide is piped.

Min. Exhaust Rates

(According to Ashrae 62.1 2019ed.)

Occupancy Category	Exhaust Rate, cfm/unit	Exhaust Rate, cfm/ft^2	Notes	Exhaust Rate, L/s·unit	Exhaust Rate, L/s·m^2	Air Class
Animal Facilities						
Animal imaging (MRI/CT/PET)	—	0.90		—	4.5	3
Animal operating rooms	—	3.00		—	15	3
Animal postoperative recovery room	—	1.50		—	7.5	3
Animal preparation rooms	—	1.50		—	7.5	3
Animal procedure room	—	2.25		—	11.3	3
Animal surgery scrub	—	1.50		—	7.5	3
Large-animal holding room	—	2.25		—	11.3	3
Necropsy	—	2.25		—	11.3	3
Small-animal-cage room (static cages)	—	2.25		—	11.3	3
Small-animal-cage room (ventilated cages)	—	1.50		—	7.5	3
Arenas	—	0.50	B	—	—	1
Art classrooms	—	0.70		—	3.5	2
Auto repair rooms	—	1.50	A	—	7.5	2
Barber shops	—	0.50		—	2.5	2
Beauty and nail salons	—	0.60		—	3.0	2
Cells with toilet	—	1.00		—	5.0	2
Copy, printing rooms	—	0.50		—	2.5	2
Darkrooms	—	1.00		—	5.0	2
Educational science laboratories	—	1.00		—	5.0	2
Janitor closets, trash rooms, recycling	—	1.00		—	5.0	3
Kitchenettes	—	0.30		—	1.5	2
Kitchens—commercial	—	0.70		—	3.5	2
Locker rooms for athletic, industrial, and health care facilities	—	0.50		—	2.5	2
All other locker rooms	—	0.25	—	—	1.25	2
Shower rooms	20/50		G,I	10/25		2
Paint spray booths	—	—	F	—	—	4
Parking garages	—	0.75	C	—	3.7	2
Pet shops (animal areas)	—	0.90	—	—	4.5	2
Refrigerating machinery rooms	—	—	F	—	—	3
Residential kitchens	50/100	—	G	25/50	—	2
Soiled laundry storage rooms	—	1.00	F	—	5.0	3
Storage rooms, chemical	—	1.50	F	—	7.5	4
Toilets—private	25/50	—	E, H	12.5/25	—	2
Toilets—public	50/70	—	D, H	25/35	—	2
Woodwork shop/classrooms	—	0.50	—	—	2.5	2

NOTES:

A Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.

B Where combustion equipment is intended to be used on the playing surface, additional dilution ventilation, source control, or both shall be provided.

C Exhaust shall not be required where two or more sides compose walls that are at least 50% open to the outside.

D Rate is per water closet, urinal, or both. Provide the higher rate where periods of heavy use are expected to occur. The lower rate shall be permitted to be used otherwise.

E Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during hours of use, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

F See other applicable standards for exhaust rate.

G For continuous system operation, the lower rate shall be permitted to be used. Otherwise the higher rate shall be used.

H Exhaust air that has been cleaned to meet Class 1 criteria from Section 5.18.1 shall be permitted to be recirculated.

I Rate is per showerhead.

Min Distance Between Fresh Air Intake and Exhaust Air Aoutlet

(ASHRAE 62.1 2019ED Table 5.1)

Table 5-1 Air Intake Minimum Separation Distance

Object	Minimum Distance, ft (m)
Class 2 air exhaust/relief outlet	10 (3)
Class 3 air exhaust/relief outlet	15 (5)
Class 4 air exhaust/relief outlet	30 (10)
Cooling tower exhaust	25 (7.5)
Cooling tower intake or basin	15 (5)
Driveway, street, or parking place	5 (1.5)
Garage entry, automobile loading area, or drive-in queue	15 (5)
Garbage storage/pick-up area, dumpsters	15 (5)
Plumbing vents terminating at least 3 ft (1 m) above the level of the outdoor air intake	3 (1)
Plumbing vents terminating less than 3 ft (1 m) above the level of the outdoor air intake	10 (3)
Roof, landscaped grade, or other surface directly below intake	1 (0.30)
Thoroughfare with high traffic volume	25 (7.5)
Truck loading area or dock, bus parking/idling area	25 (7.5)
Vents, chimneys, and flues from combustion appliances and equipment	15 (5)

Ventilation Rule of thumb for Some Special Rooms

1.Electrical Room

A.Recommended Minimum Ventilation Rate

1) 2.0 CFM/sq.ft.

2)10.0 AC/hr.

3)5 CFM/KVA of transformer.

B.Electrical Room Design Guidelines

1. Determine heat gain from transformers, panelboards, and other electrical equipment contained in the electrical room. Then, determine required airflow for ventilation or tempering of space.

2. Generally, electrical equipment rooms only require ventilation to keep equipment fromoverheating. Most electrical rooms are designed for 95F to 104F; however, consult the electrical engineer for equipment temperature tolerances. If space temperatures 90F and below are required by equipment, air conditioning (tempering) of the space will be required.

3. If outside air is used to ventilate the electrical room, the electrical room design temperature will be 10F to 15F above outside summer design temperatures.

4. If conditioned air from an adjacent space is used to ventilate the electrical room, the electrical room temperature can be 10F to 20F above the adjacent spaces.

2.Mechanical Rooms

A.Recommended Minimum Ventilation Rate

1) 2.0 CFM/sq.ft.

2)10.0 AC/hr.

B.Mechanical Room Design Guidelines

Determine heat gain from motors, pumps, fans, transformers, panelboards, and othermechanical and electrical equipment contained in the mechanical room. Then, determine the required airflow for the ventilation or tempering of space.Generally, mchanical equipment rooms only require ventilation. Most mechanical rooms are designed for 95F to 104F; however, verify mechanical equipment temperature tolerances. If space temperatures below 908F are required by mechanical equipment, airconditioning (tempering) of the space will be required. A number of products (DDC control panels, variable frequency drives, other electronic components) will perform better if the mechanical room is tempered in lieu of just ventilating the room.If outside air is used to ventilate the mechanical room, the mechanical room design temperature will be 10F to 15F above outside summer design temperatures. If conditioned air from an adjacent space is used to ventilate the mechanical room, the mechanical room temperature can be 108F to 208F above the adjacent spaces.

3.Boilers Room

A. 8 CFM/BHP combustion air.

B. 2 CFM/BHP ventilation.

C. 1 BHP = 34,500 Btuh.

CHAPTER 2

DUCT

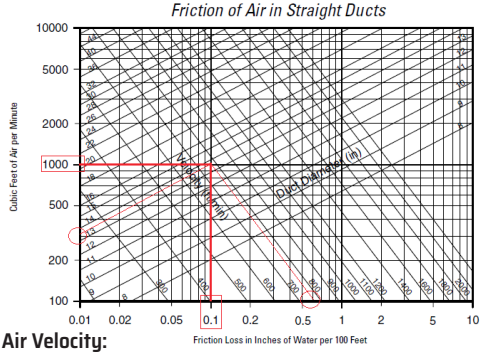
DUCT SIZING

The methods used to size air ducts are the equal friction method, velocity reduction and static regain.

Procedure:

1.Select maximum air velocity in main duct after fan outlet.
2.Enter the friction chart knowing the cfm and velocity to determine the friction rate / 100 ft of duct length and select the diameter.
3. From the friction rate obtained, use the same value to determine diameters for all other sections of the ductwork.
4. The total friction loss in the duct system is then calculated by multiplying the friction loss per 100-foot of length to the equivalent length of the most critical path of the ductwork having maximum resistance.

Friction of Air in Straight Ducts



Air Velocity:

Table A1 provides guidelines for air velocity through duct airways, supply outlets and return grilles. If recommended velocities are used, system resistance and generated noise are less than if maximum velocities are used.
As far as resistance is concerned, the maximum velocity limit may be exceeded if the available ESP produced by the blower equals or exceeds system resistance.

Duct Loss Estimating:

• Layout single line duct diagram, duct velocity and the Design Flow Loss (DFL – pressure loss/100' of duct).
• Select most likely critical path, Measure Total Duct Length (TDL) including supply and return paths along critical path.
• Tabulate the type and quantity of duct fittings along critical path.
• Utilize the Fitting Loss charts in this section to determine the
Total Equivalent Length (TEL) of duct for all fittings. Tables are for 900 Fpm air velocity and for a 0.08 IWC/100 Ft friction rate.
The equivalent length values for return-side fittings are for 700 Fpm air velocity and for a 0.08 IWC/100 Ft friction rate. This information appears at the top of each page of the fitting tables.
• Use Fitting Loss Conversion Factors equation to convert equivalent length for other system design conditions other than 900 fpm and 0.08" w.g./100 feet of duct.
The equivalent length (ELx) for another velocity (Vx) or another friction rate (FRx) is calculated by this equation:

$$EL_x = EL^* (VX / VA)^2 * (FR_A / FR_X)$$

• Calculate estimated duct system losses as follows:
[(TDL +TEL) x DFL] / 100
• Add losses from other components
Common external static pressure losses
• Throwaway Filter - 0.1"
• Supply Outlet - 0.1"
• Return Inlet - 0.1"
• Flex duct (5' smooth radius elbow to inlet/outlet) = 120'ft Total equivalent length.

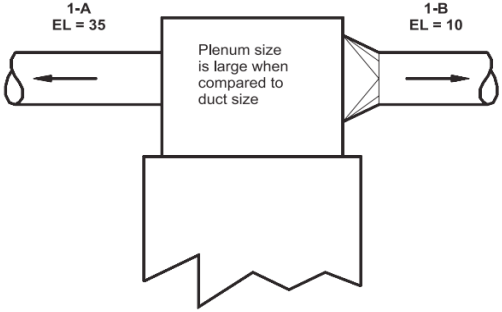
Carrier Air System Design Manual

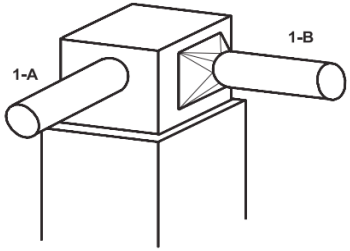
Application	Controlling Factor				
	Noise Generation	Duct Friction			
	Main Ducts	Main Ducts		Branch Ducts	
Residences,private	600	Supply	Return	Supply	Return
Apartments, hotel rooms, hospital rooms	1000	1000	800	600	600
Private offices, libraries	1200	1200	1300	1200	1000
Theaters, auditoriums	800	2000	1500	1600	1200
General offices, upscale restaurants, upscale stores, banks	1500	1300	1100	1000	800
General stores, cafeterias	1800	2000	1500	1600	1200
Industrial	2500	3000	1800	2200	1500

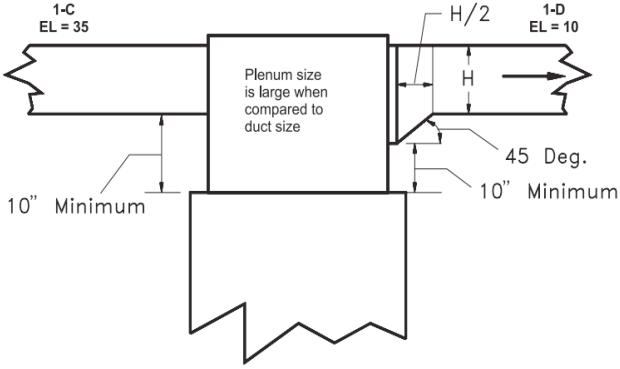
Group 1 (ACCA Manual D, 2014)

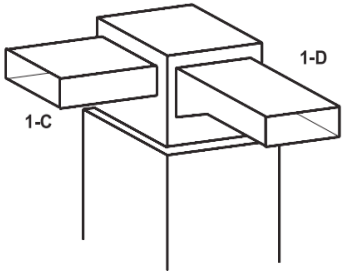
Supply Air Fittings at the Air Handling Equipment

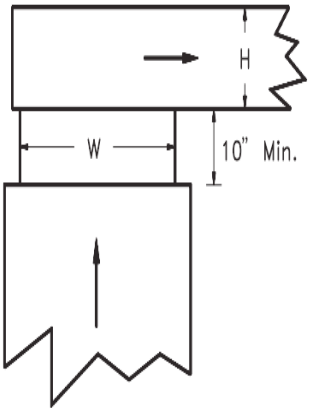
(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)

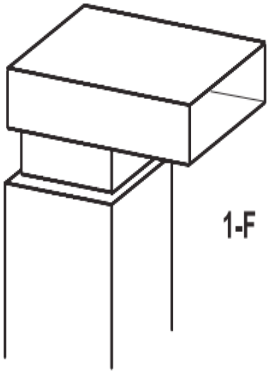






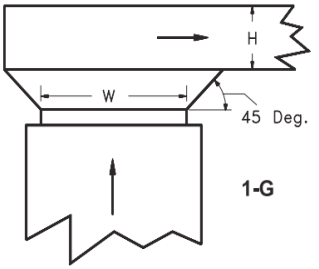




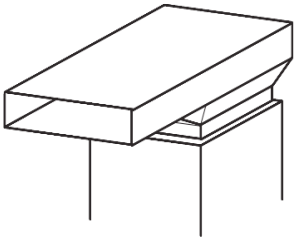


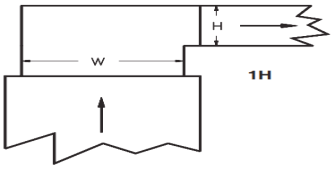
Bull Head 1F	H / W	EL
	0.50	120
	1.0	85

Tapered Head 1G	H / W	EL
	0.50	35
	1.0	25



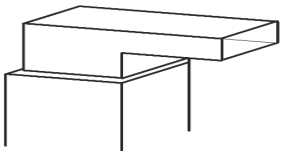
1-G

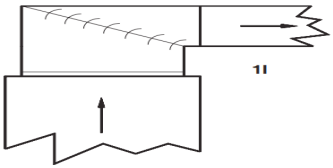




1H

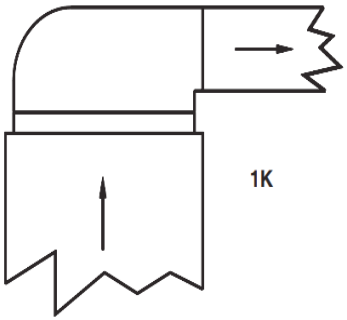
No Vanes 1H	H / W	EL
	0.5	120
	1.0	85





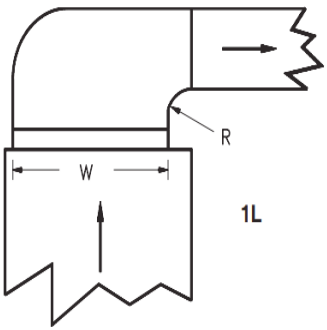
1I

With Vanes 1I	EL = 20

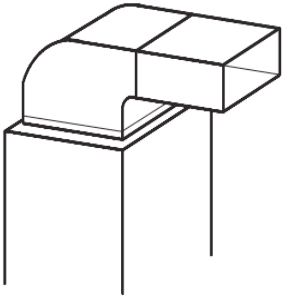


1K

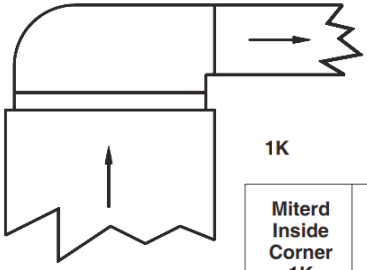
Miterd Inside Corner 1K	EL = 85



1L

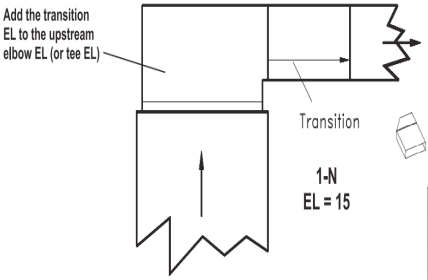


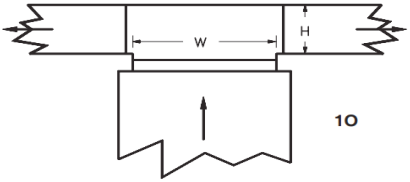
Radius Ell No Vanes 1L	R / W	EL
	0.25	40
	0.50	20
	1.0	10



1K

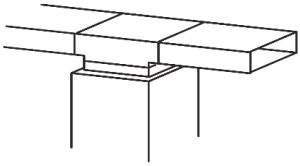
Miterd Inside Corner 1K	EL = 85

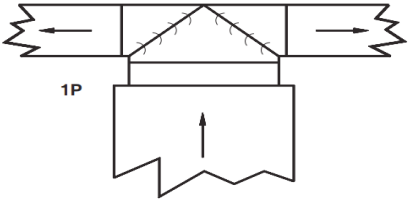




1O

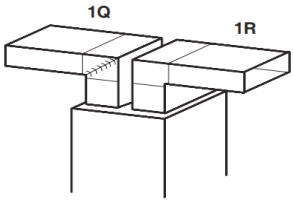
Bull Head No Vanes 1O	H / W	EL
	0.50	120
	1.0	85

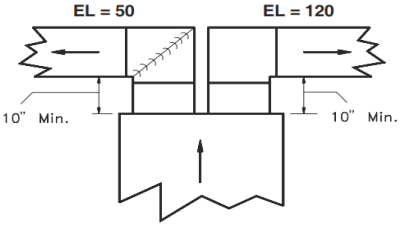




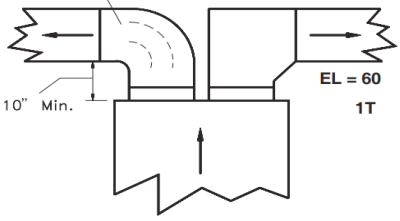
1P

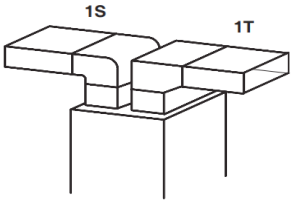
Vaned Tee 1P	EL = 20



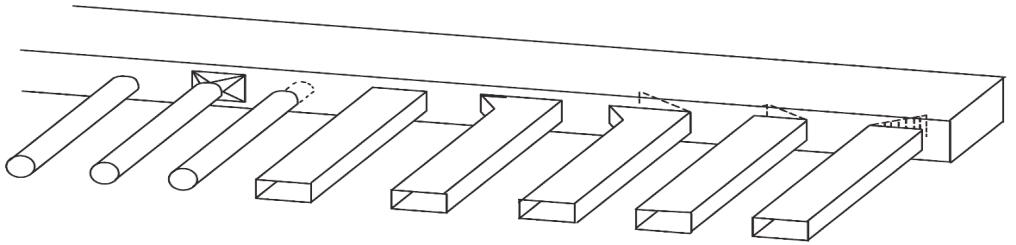


Radius Elbow 1S	Vanes	EL
	0	60
	1	40
	2	30



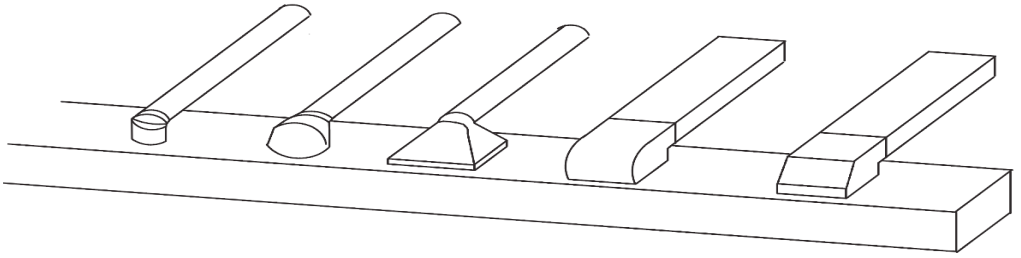


Group 2 (ACCA Manual D, 2014)
Branch Takeoff Fittings at the Supply Trunk
(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)



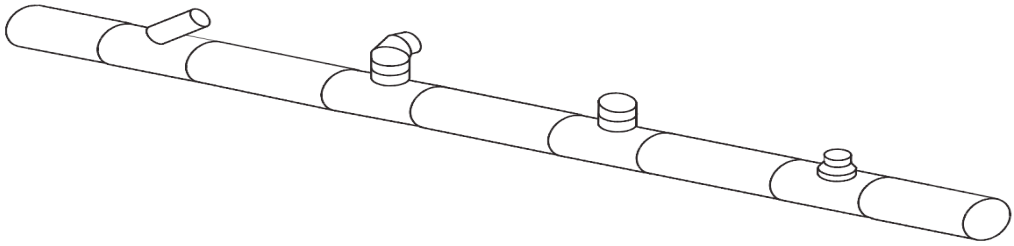
EL Values		Number of Downstream Branches to End of Trunk Duct or Number of Downstream Branches to a Trunk Reducer					
Fitting		0	1	2	3	4	5 or More
	2A	35	45	55	65	70	80
	2B	20	30	35	40	45	50
	2C	65	65	65	65	70	80
	2D	40	50	60	65	75	85
	2E	25	30	35	40	45	50
	2F	20	20	20	20	25	25
	2G	65	65	65	70	80	90
	2H	70	70	70	75	85	95

Note: If the trunk has a reducer, count down to the reducer; then begin a new count after the reducer.



EL Values		Number of Downstream Branches to End of Trunk Duct or Number of Downstream Branches to a Trunk Reducer					
Fitting		0	1	2	3	4	5 or More
	2I	65	75	85	95	100	110
	2J	50	60	65	70	75	80
	2K	50	60	65	70	75	80
	2L	70	80	90	95	105	115
	2M	70	80	90	95	105	115

Note: If the trunk has a reducer, count down to the reducer; then begin a new count after the reducer.

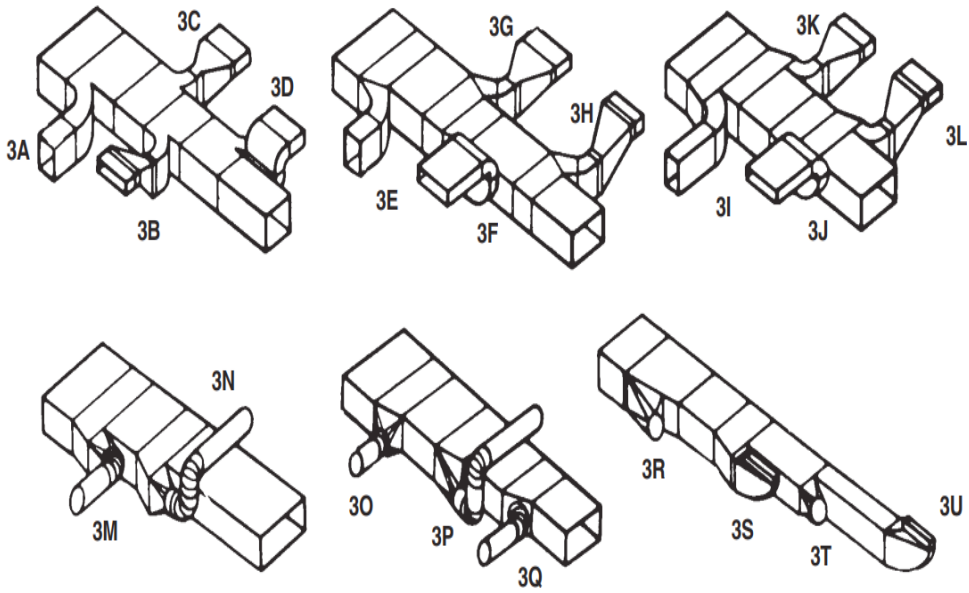


EL Values		Number of Downstream Branches to End of Trunk Duct or Number of Downstream Branches to a Trunk Reducer					
Fitting		0	1	2	3	4	5 or More
	2N	35	35	40	40	40	40
	2O	55	65	75	85	90	100
	2P	50	55	60	65	70	75
	2Q	10	10	15	20	20	25

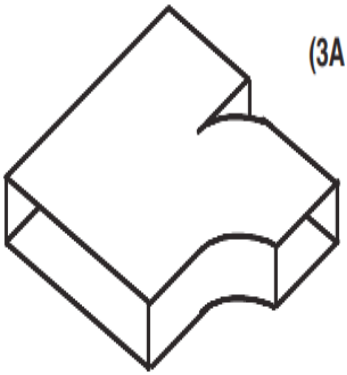
Note: If the trunk has a reducer, count down to the reducer; then begin a new count after the reducer.

Group 3 (ACCA Manual D, 2014)
Reducing Trunk Takeoff Fittings

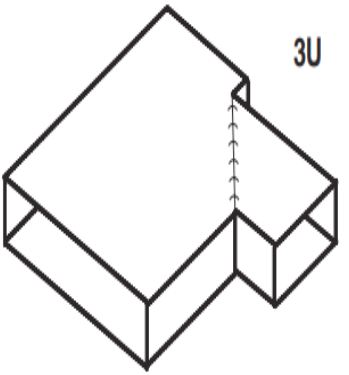
(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)



Fitting ID	EL	Description of Assembly
3A and 3I	15	Full radius takeoff
3B and 3L	30	Full radius takeoff plus offset transition
3C and 3K	20	Full radius takeoff plus straight transition
3D and 3J	35	Radius takeoff elbow (see 3S) plus easy-bend elbow
	55	Tight radius takeoff elbow (see 3S) plus easy-bend elbow
	110	Miterd inside corner takeoff elbow (see 3S) plus easy-bend elbow
3E	30	Transition wall takeoff
3F	3D + 15	Transition wall takeoff elbow (radius, tight radius or Miterd corner) plus easy-bend elbow
3G	35	Transition wall takeoff plus straight-aspect transition
3H	35	Transition wall takeoff plus offset-aspect transition
3M	25	In line eased takeoff fitting (see 3T) plus one elbow
3N	40	In line eased takeoff fitting (see 3T) plus two elbows
3O and 3R	20	Transition wall eased takeoff fitting (see note)
3P	50	Transition wall eased takeoff fitting plus two elbows (see note)
3Q	35	Transition wall eased takeoff fitting plus one elbow (see note)
3S and 3U	15	Full radius takeoff elbow
	35	Tight inside radius takeoff elbow
	90	Miterd inside corner takeoff elbow
3T	10	In line eased takeoff fitting
Note: Add 15 feet to the equivalent length if a round sleeve is simply butted to the transition wall.		



Full Radius Takeoff 3A or 3I	EL = 15

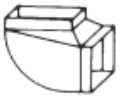


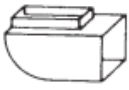
Miterd Takeoff 3U	Vanes	EL
	Yes	10
	No	80

Group 4 (ACCA Manual D, 2014)
Supply Air Boot and Stack Head Fittings

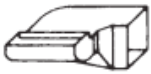
(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)


4A
EL = 30


4B
EL = 35


4C
EL = 60


4D
EL = 55


4E
EL = 70


4F
EL = 45


4G
EL = 80


4H
EL = 50

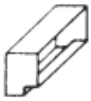

4I
EL = 10


4J
EL = 30


4K
EL = 30

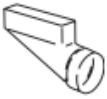

4L
EL = 80


4M
EL = 20


4N
EL = 45


4O
EL = 20


4P
EL = 10


4Q
EL = 50


4R
EL = 20


4S
EL = 20


4T
EL = 20


4U
EL = 20


4V
EL = 60


4W
EL = 35


4X
EL = 35


4Y
EL = 35


4Z
EL = 60


4AA
EL = 35


4AB
EL = 90


4AC
EL = 100


4AD
EL = 60


4AE
EL = 55


4AF
EL = 50


4AG
EL = 60


4AH
EL = 60


4AI
EL = 20


4AJ
EL = 25


4AK
EL = 55


4AL
EL = 70


4AM
EL = 70


4AN
EL = 70

4AO
EL = 40

4AP
EL = 40

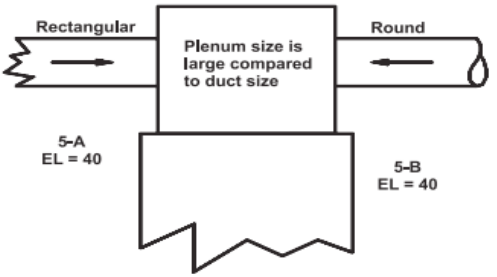
4AQ
EL = 10

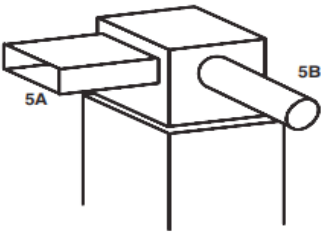
4AR
EL = 70

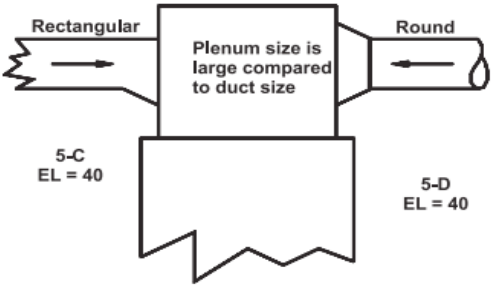
Group 5 (ACCA Manual D, 2014)

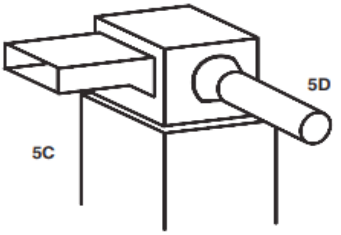
Return Air Fittings at the Air Handling Equipment

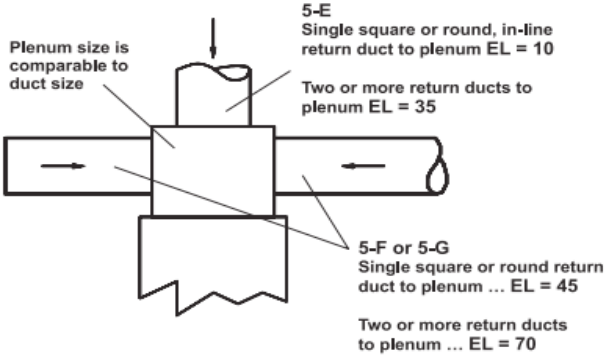
(Reference Velocity = 700 Fpm & Friction Rate = 0.08 IWC per 100 Feet)

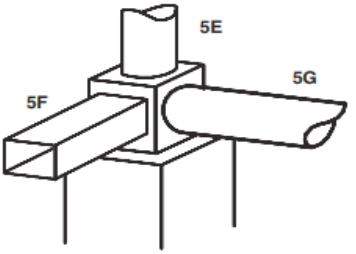


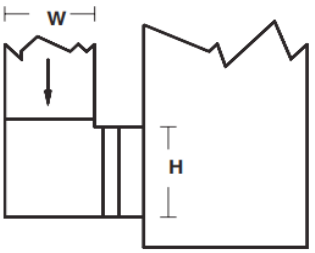


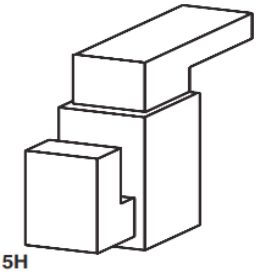






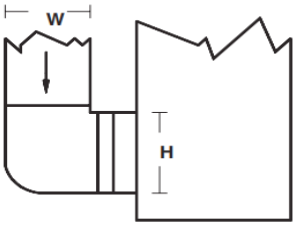


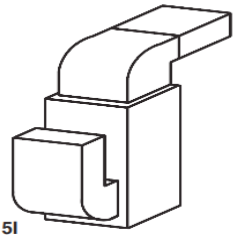


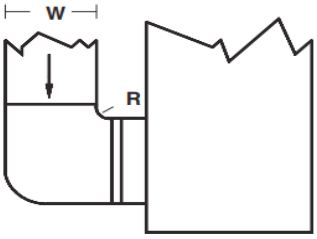


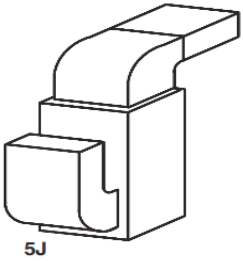
Square Elbow 5H	H / W	EL
	1	45
	2	30

Miterd Inside Corner 5I	H / W	EL
	1	45
	2	30



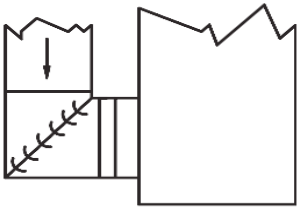


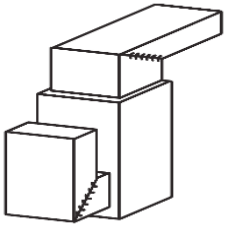


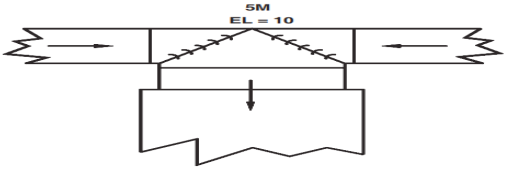


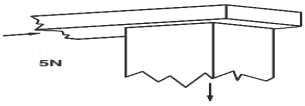
Radius Elbow 5J	R / W	EL
	0.25	20
	0.50	15
	1.00	10

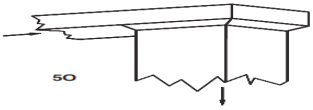
Square Elbow with Vanes 5K	EL
	10

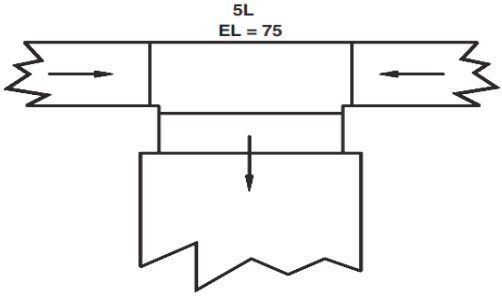


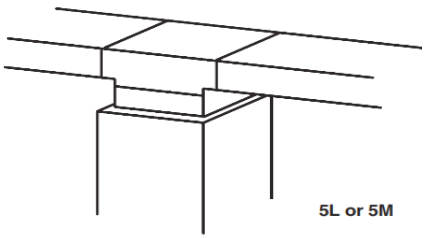




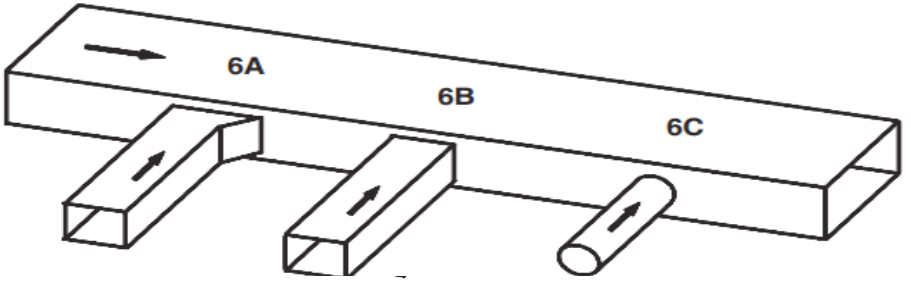


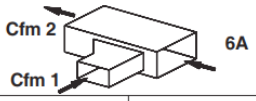
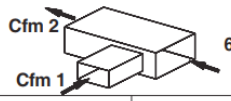
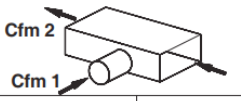


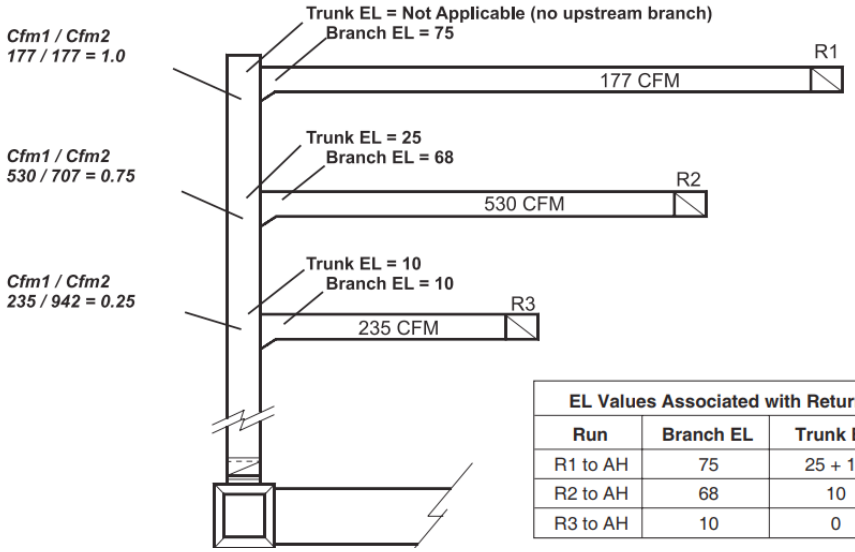




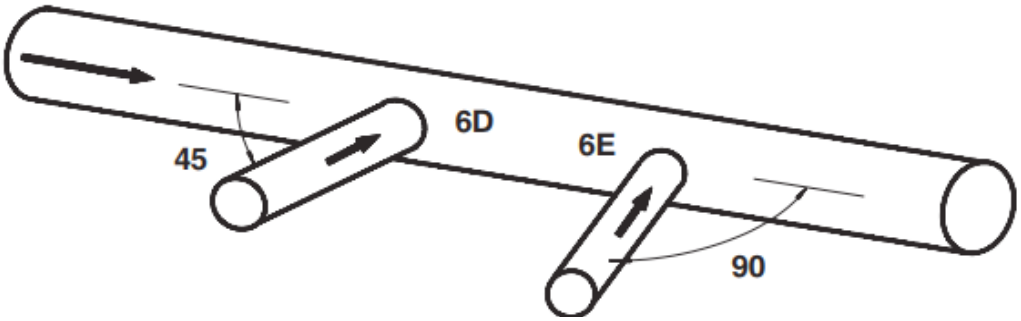
Group 6 (ACCA Manual D, 2014)
Branch Return Air Fittings at the Return Trunk
(Reference Velocity = 700 Fpm & Friction Rate = 0.08 IWC per 100 Feet)

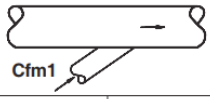


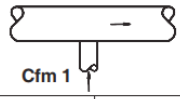
						
Cfm1/Cfm2	**Branch EL**	**Trunk EL**	**Branch EL**	**Trunk EL**	**Branch EL**	**Trunk EL**
0.40 or less	10	10	10	10	10	10
0.50	25	25	40	25	30	25
0.60	40	25	40	25	50	25
0.70	60	25	75	25	75	25
0.80	75	25	110	25	115	25
1.00	75	NA	110	NA	115	NA
The branch EL value applies to the turn and the trunk EL value applies to the upstream fittings (see example below).						



EL Values Associated with Return Trunk Fittings			
Run	**Branch EL**	**Trunk EL**	**Total EL**
R1 to AH	75	25 + 10	110
R2 to AH	68	10	78
R3 to AH	10	0	10



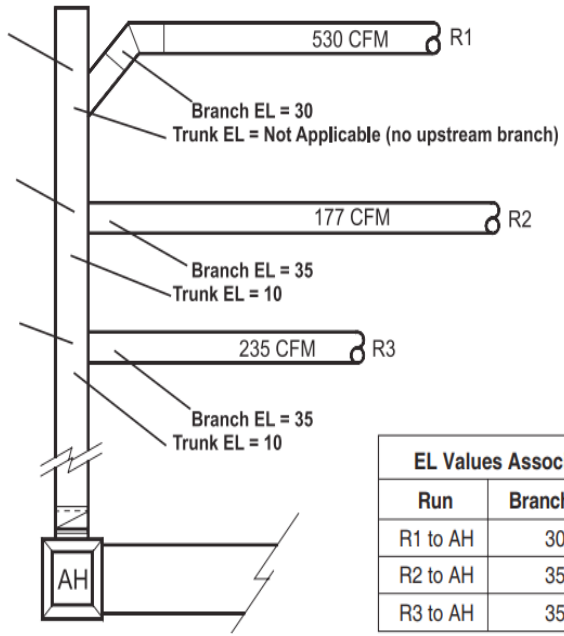
	 Cfm2 Cfm1 6D	
Cfm1/Cfm2	Branch EL	Trunk EL
0.10	10	5
0.20	15	5
0.30	20	5
0.40	30	5
0.60	30	5
0.80	30	5
1.00	30	NA
Refer to example below		

	 Cfm 2 Cfm 1 6E	
Cfm1/Cfm2	Branch EL	Trunk EL
0.10	15	10
0.20	30	10
0.30	40	10
0.40	40	10
0.50	40	25
0.80	40	25
1.00	40	NA
Refer to example below		

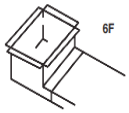
Cfm1 / Cfm2
530 / 530 = 1.0

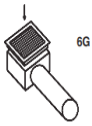
Cfm1 / Cfm2
177 / 707 = 0.25

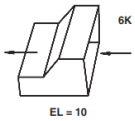
Cfm1 / Cfm2
235 / 942 = 0.25

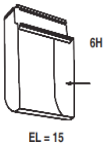


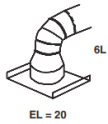
EL Values Associated with Return Trunk Fittings			
Run	Branch EL	Trunk EL	Total EL
R1 to AH	30	10 + 10	50
R2 to AH	35	10	45
R3 to AH	35	0	35

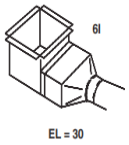


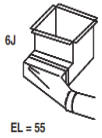


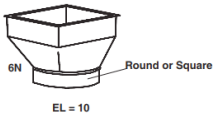


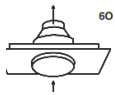


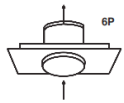








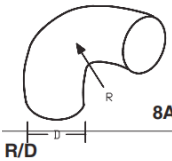




Group 7 (ACCA Manual D, 2014)

Elbows and Offsets

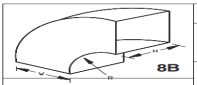
(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)



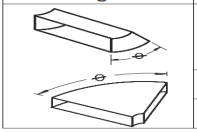
R/D	Round and Oval Elbow EL Values							
	Smooth	4 or 5 Piece	3 Piece	Smooth Miterd	Easy Bend	Hard Bend	3-Piece 45°	2-Piece 45°
Miterd (R = 0)	—	—	—	75	4-Piece 25	4-Piece 30	10	15
0.75	20	30	35	—				
1.0	15	20	25	—	3-Piece 30	3-Piece 35		
1.5 or Larger	10	15	20	—				

8A — Continued

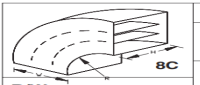
For Smooth Radius Round Elbows Angles (θ) Less Than 90° Multiply EL by One of the Following Factors							
20°	30°	45°	60°	75°	110°	130°	150°
0.31	0.45	0.60	0.78	0.90	1.13	1.20	1.28



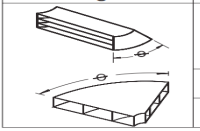
R/W	Radius Elbow EL Values		
	Hard Bend	H / W = 1	Easy Bend
Miterd (R = 0)	90	75	65
0.25	35	30	25
0.5 or Larger	20	15	10



For Angles (θ) Less Than 90° Multiply EL by One of the Following Factors		
30°	45°	60°
0.45	0.60	0.78

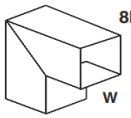


R/W	Radius Elbow EL Values		
	Hard Bend	H / W = 1	Easy Bend
Miterd (R = 0)	30	25	40
0.25	10	10	10
0.5 or Larger	5	5	5



For Angles (θ) Less Than 90° Multiply EL by One of the Following Factors		
30°	45°	60°
0.45	0.60	0.78

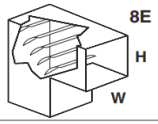
8D



Square Elbow EL Values		
Hard Bend	H / W = 1	Easy Bend
80	80	65

No Vanes

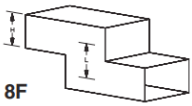
8E



Square Elbow EL Values		
Hard Bend	H / W = 1	Easy Bend
10	10	10

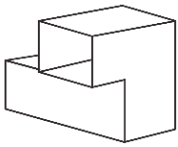
Single Thickness Turning Vanes

L/H	EL
1	160
2	260
4	190



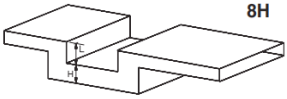
8F

No Vanes



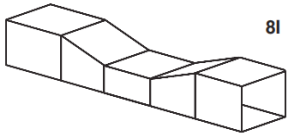
8G

EL = 200
No Vanes



8H

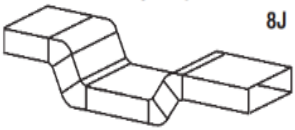
EL's H/L	No Vanes	With Vanes
0.5	55	—
1.0	330	55
1.5	430	55
2.0	470	55



8I

EL = 20

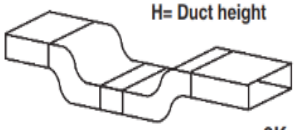
4 — 45° Ells



8J

EL = 20

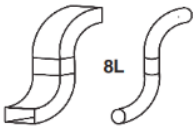
R = Inside radius
H= Duct height



4 — 90° Ells

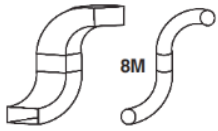
8K

R/H	EL
Miterd (R=0)	250
0.25	100
0.50	20
1.00	20



8L

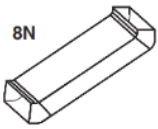
Double Ell — 1 Plane
1.7 x EL value for single elbow



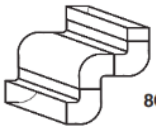
8M

Double Ell — 2 Plane
2.0 x EL value for single elbow

EL = 10

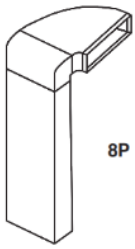


8N



8O

Inside Corner	EL
Miter (R=0)	235
R = 0.25	90
R > 0.50	45



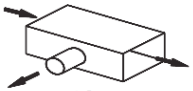
8P

EL Values	Inside Corners	
Riser	Miter	Radius
3-1/4 x 10	75	60
3-1/4 x 12	90	75
3-1/4 x 14	90	75

Group 8 (ACCA Manual D, 2014)
Supply Trunk Junction Fittings

(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)

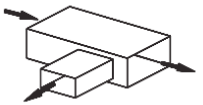
The equivalent lengths for this group apply when the branch duct is a secondary trunk duct. See Group 2, Branch Takeoff Fittings for branch runout equivalent length values.



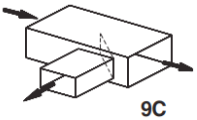
9A

	EL
Branch	80
Main	5

	EL
Branch	80
Main	5



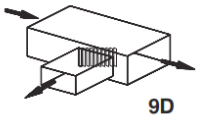
9B



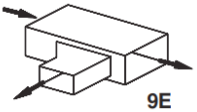
9C

	EL
Branch	80
Main	5

	EL
Branch	75
Main	5



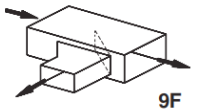
9D



9E

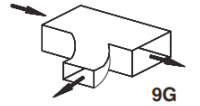
	EL
Branch	50
Main	5

	EL
Branch	45
Main	5

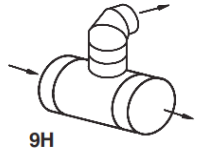


9F

	EL
Branch	35
Main	5



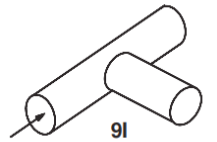
9G



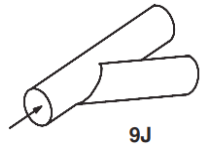
9H

	EL
Branch	100
Main	5

	EL
Branch	85
Main	5



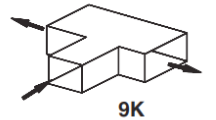
9I



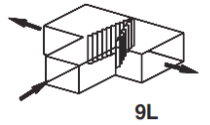
9J

	EL
Branch	25
Main	5

EL = 65



9K



9L

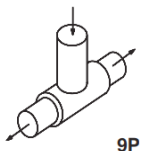
EL = 20

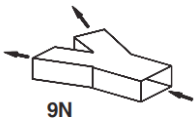
EL = 20

9M

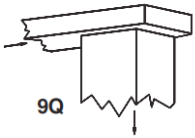
The equivalent lengths for this group apply when the branch duct is a secondary trunk duct. See Group 2, Branch Takeoff Fittings for branch runout equivalent length values.

EL = 70


9P

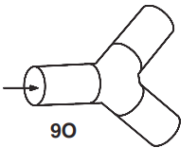

9N

EL = 15

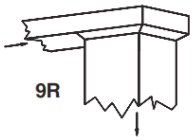

9Q

EL = 55

EL = 15


9O

EL = 35

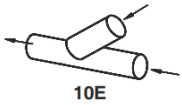

9R

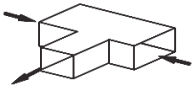
Group 9 (ACCA Manual D, 2014)
Return Trunk Junction Fittings

(Reference Velocity = 700 Fpm & Friction Rate = 0.08 IWC per 100 Feet)

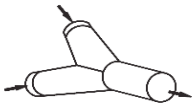
The equivalent lengths in this group apply when the flow in two return trunks merge. See Group 6, Branch Return Fittings, for branch return equivalent length values.

EL = 25


10E

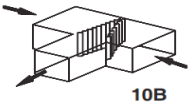

10A

EL = 75

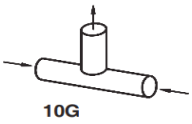

10F

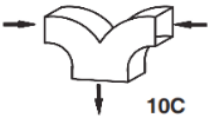
EL = 35

EL = 10


10B

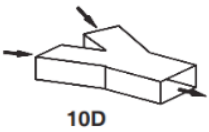
EL = 75


10G

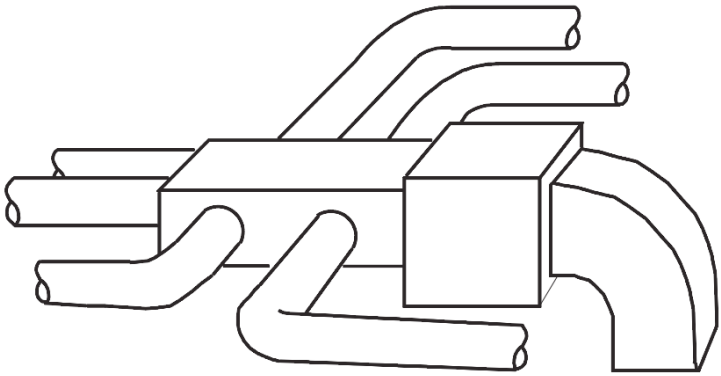

10C

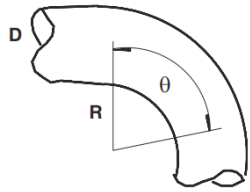
EL = 10

EL = 25


10D

Group 10 (ACCA Manual D, 2014)
Flexible Duct Junction Boxes and Radius Bends
(Reference Velocity = As Indicated & Friction Rate = 0.08 IWC per 100 Feet)

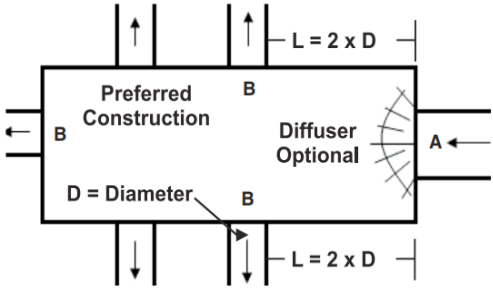




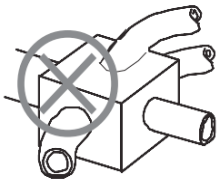
For bends that are not equal to 90°, multiply the 90° equivalent length by the ratio of the desired angle to the 90° angle.

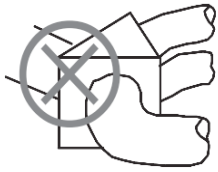
Example: IF R/D = 1.0, find the EL for a 45° bend if the velocity equals 700 Fpm.

15 x 45 / 90 = 7.5 Ft



Recommended (compatible with Group 11 EL values)
- Entrance (A) has a diffuser fitting that recovers velocity pressures and prevents swirl (optional).
- Straight approach(A) and straight exit (B).
- Exit opening on side (no top or bottom exits).
- Exit opening at least two diameters from entrance (L).
- Make box as small as possible, but comply with L = 2 x D.





Equivalent Length Values

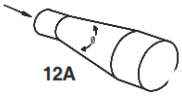
Velocity in Flex Duct (Fpm)	Junction Box (Ft) Notes 1, 2 and 3	90° Bend (Ft) R / D Ratio (In / In) [4]			
		1.0	1.5	2 to 3	4 to 5
400	20	5	5	5	5
500	30	5	5	5	5
600	40	10	5	5	5
700	60	15	10	5	5
800	75	15	10	10	8
900	95	20	15	10	8

1) No anti-swirl regain diffuser at entrance.
- Swirl tends to feed one side of the box and starve the other side.
- Swirl may be induced by spiral wire geometry.
- Swirl attributes (such as direction) may change when the blower shuts down and restarts.

2) Straight-run approach and a straight-run departures (no turns in duct runs near the junction box).
3) Entrance and exits on side of box (no top or bottom openings).
4) Radius of turn divided by diameter of duct.

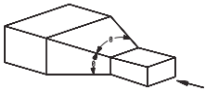
Group 11 (ACCA Manual D, 2014)
Transitions (Diverging)

(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)



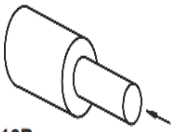
12A

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	40
2:1	20	40
4:1	20	30



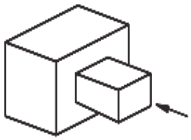
12F

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	40
2:1	20	40
4:1	15	30



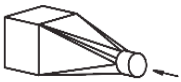
12B

EL Values	A1/A2	A1/A2
Slope	2	4
Abrupt	20	40



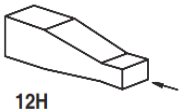
12G

EL Values	A1/A2	A1/A2
Slope	2	4
Abrupt	20	40



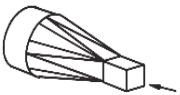
12C

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	40
2:1	20	40
4:1	20	30



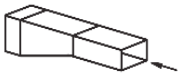
12H

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	40
2:1	20	40
4:1	15	25



12D

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	40
2:1	20	40
4:1	20	30

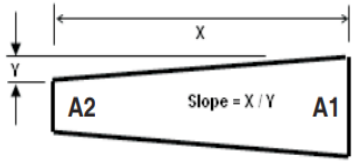


12I

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	20	35
2:1	15	25
4:1	10	10

12E

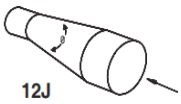
EL = 25



A1 / A2 = Larger Area / Smaller Area

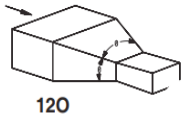
Group 12 (ACCA Manual D, 2014)
Transitions (Converging)

(Reference Velocity = 900 Fpm & Friction Rate = 0.08 IWC per 100 Feet)



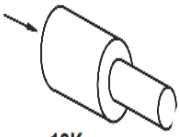
12J

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	10	10
2:1	5	5
4:1	5	5



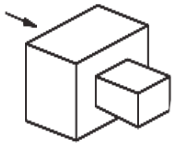
12O

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	10	10
2:1	5	5
4:1	5	5



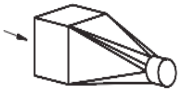
12K

EL Values	A1/A2	A1/A2
Slope	2	4
Abrupt	25	25



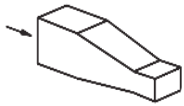
12P

EL Values	A1/A2	A1/A2
Slope	2	4
Abrupt	30	30



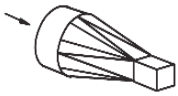
12L

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	10	10
2:1	5	5
4:1	5	5



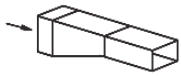
12Q

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	10	10
2:1	5	5
4:1	5	5



12M

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	10	10
2:1	5	5
4:1	5	5

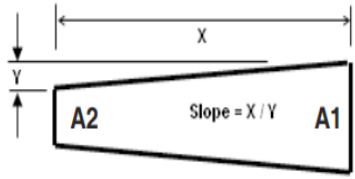


12R

EL Values	A1/A2	A1/A2
Slope	2	4
1:1	5	5
2:1	5	5
4:1	5	5

12N

EL = 10



A1 / A2 = Larger Area / Smaller Area

CHAPTER 3

PIPING SYSTEM

PIPING SYSTEM

This Section deals with hydronic piping materials, joining methods, valves, control devices, strainers and flexible connectors. Hydronics is the use of water as the heat-transfer medium in heating and cooling systems. A hydronic piping system is used to circulate chilled or hot water with the connections between the piping and the terminal units made in a series loop (Closed Loop) and between Chiller and Cooling Tower in open loop.

Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1.Chilled-Water Piping: 1520 kPa at 16 °C., Schedule 40 all pipe sizes with grooved/mechanical coupling.
2.Condenser-Water Piping: 1030 kPa at 49 °C.,
3.Schedule 40 for piping DN 300 and smaller, Standard Schedule for piping larger than DN 300.
4.Makeup-Water Piping: 1030 kPa at 24 °C., Schedule 40.
5.Condensate-Drain Piping: 24 °C.
6.Blowdown-Drain Piping: 49 °C.
7.Air-Vent Piping: 49 °C.
8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

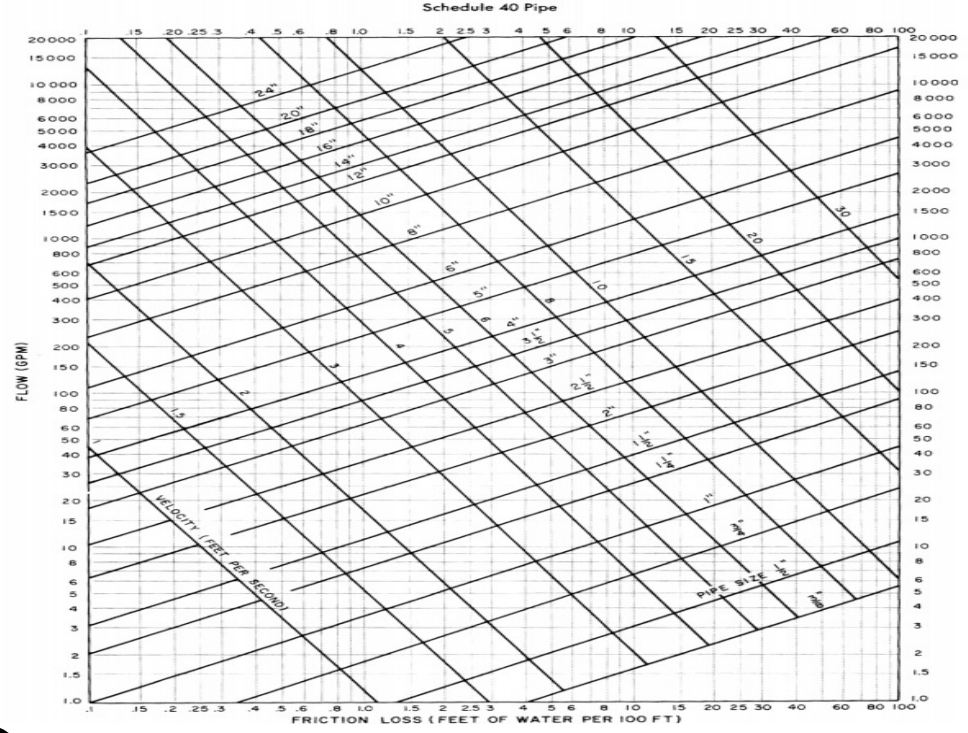
For Closed loop Pipe sizing

CHILIED WATER PIPE SIZING					
CHILIED WATER PIPE SIZING AS PER ASHRSE STANDARD IF Ø<=2"- 4 FPS AND IF Ø >2"- 4 FT/ 100 FT OF PIPE LENGTH					
IMPERIAL			SI		
Water floow rate in GPM min	max	pipe size (inch)	water flow rate in LPS min	max	pipe size (mm)
0	2.8	0.5"	0.0	0.2	15
2.9	5	0.75"	0.2	0.3	20
5.1	8	1"	0.3	0.5	25
8.1	14	1.25"	0.5	0.9	32
14.1	20	1.5"	0.9	1.3	40
20.1	40	2"	1.3	2.5	50
40.1	70	2.5"	2.5	4.4	65
70.1	120	3"	4.4	7.6	80
120.1	250	4"	7.6	15.8	100
250.1	450	5"	15.8	28.4	125
450.1	700	6"	28.4	44.1	150
700.1	1300	8"	44.1	81.9	200
1300.1	2500	10"	81.9	157.5	250
2500.1	4000	12"	157.5	252.0	300

Operating Hours/Year	<= 2000 hours/year		>2000 and <= 4400 hours/year		>4400 hours/year	
Nominal pipe Size, inches	Other	Variable flow/ Variable speed	Other	Variable flow/ Variable speed	Other	Variable flow/ Variable speed
21/2	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	350	260	400	210	320
5	410	410	310	470	250	370
6	740	740	570	860	440	680
8	1200	1200	900	1400	700	1100
10	1800	1800	1300	2000	1000	1600
12	2500	2500	1900	2900	1500	2300
Maximum velocity for pipes 14 to 24" in size	8.5 ft/s	8.5 ft/s	6.5 ft/s	9.5 ft/s	5.0 ft/s	7.5 ft/s

ASHRAE 90.1-2019 maximum flow rate (gpm) by pipe size, hours of operation and application

For Open loop use Following chart



And for drainage Pipe:

EQUIPMENT CAPACITY	MINIMUM CONDENSATE PIPE DIAMETER
Up to 20 tons of refrigeration	0.75 inch
Over 20 tons to 40 tons of refrigeration	1 inch
Over 40 tons to 90 tons of refrigeration	1.25 inch
Over 90 tons to 125 tons of refrigeration	1.5 inch
Over 125 tons to 250 tons of refrigeration	2 inch

for SI : 1 inch = 25.4mm, 1 ton of capacity

Pipe Label Color Schedule as per ASME
ASME Pipe Marking colors

Pipe contents	Color scheme
Fire-Quenching fluids	**White Text on Red**
Toxic and corrosive fluids	**Black Text on Orange**
Flammable Fluids	**Black Text on Yellow**
Combusitble Fluids	**White Text on Brown**
potable,Cooling,Boiler,Feed,and other Water	**White Text on Green**
Compressed Air	**White Text on Blue**
User-Defined	**White Text on Purple**
User-Defined	**Black Text on White**
User-Defined	**White Text on Gray**
User-Defined	**White Text on Black**

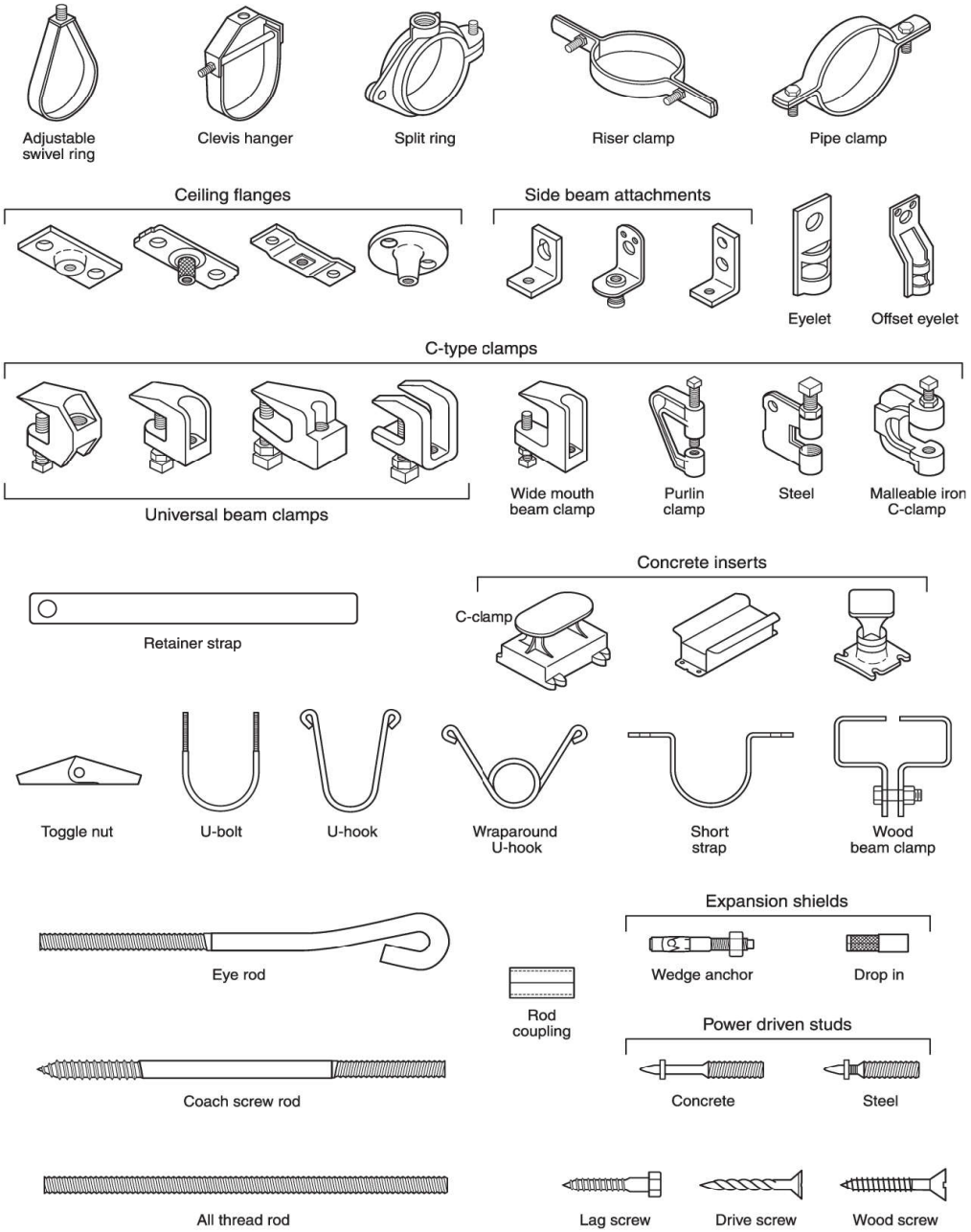
Outside Diameter (OD), SDR, PN and Weights per Meter for PE 80& PE 100 according to EN 12201 / EN 1555

SDR	SDR	7.4	SDR	9	SDR	11
PE100	PN	25	PN	20	PN	16
PE80	PN	20	PN	16	PN	12.5
ODmm	th	kg/m	th	kg/m	th	kg/m
20	3.0	0.162	2.3	0.132	2.0	0.116
25	3.5	0.240	2.8	0.199	2.3	0.170
32	4.4	0.387	3.6	0.327	3.0	0.275
40	5.5	0.603	4.5	0.510	3.7	0.429

50	6.9	0.940	5.6	0.790	4.6	0.666
63	8.6	1.479	7.1	1.263	5.8	1.054
75	10.3	2.107	8.4	1.774	6.8	1.472
90	12.3	3.019	10.1	2.559	8.2	2.133
110	15.1	4.524	12.3	3.803	10.0	3.164
125	17.1	5.822	14.0	4.904	11.4	4.105
140	19.2	7.313	15.7	6.162	12.7	5.116
160	21.9	9.520	17.9	8.024	14.6	6.716
180	24.6	12.037	20.1	10.153	16.4	8.489
200	27.4	14.892	22.4	12.555	18.2	10.469

SDR	SDR	13.6	SDR	17	SDR	21
PE100	PN	12.5	PN	10	PN	8
PE80	PN	10	PN	7.5	PN	6.5
ODmm	th	kg/m	th	kg/m	th	kg/m
20						
25	2.0	0.148				
32	2.4	0.231	2.0	0.194		
40	3.0	0.355	2.4	0.293	2.0	0.245
50	3.7	0.549	3.0	0.452	2.4	0.372
63	4.7	0.875	3.8	0.720	3.0	0.577
75	5.6	1.239	4.5	1.016	3.6	0.826
90	6.7	1.775	5.4	1.461	4.3	1.185
110	8.1	2.630	6.6	2.174	5.3	1.778
125	9.2	3.389	7.4	2.774	6.0	2.272
140	10.3	4.244	8.3	3.482	6.7	2.846
160	11.8	5.540	9.5	4.545	7.7	3.732
180	13.3	7.032	10.7	5.749	8.6	4.690
200	14.7	8.625	11.9	7.095	9.6	5.812

Hydronic Piping Supports



HANGERS AND SUPPORTS Spacing according to SECTION (23 05 29)

		Maximum Spacing			
			PVC*		
Nominal Pipe Size	Rod Diameter	Steel	Schedule 40	Schedule 80	Copper
3/8" - 1 1/4"	3/8"	7'	4'	4'	5'
1 1/2"	3/8"	9'	5'	5'	8'
2"	3/8"	10'	5'	6'	8'
2 1/2"	1/2"	11'	6'	6'	9'
3"	1/2"	12'	6'	7'	10'
3 1/2"	1/2"	13'	6'	7'	11'
4"	5/8"	14'	6'	7'	12'
5"	5/8"	16'	6'	7'	13'
6"	3/4"	17'	7'	9'	14'
8"	3/4"	19'	8'	9'	16'
10"	7/8"	22'	8'	10'	
12"	7/8"	23'	9'	10'	
14"	1"	25'	10'	11'	
16"	1"	27'	10'	11'	

Information provided by Cooper B-Line. *100°F maximum temperature.

Hangers for vertical Carbon steel pipe at each floor and at spacing not greater than 4.5 m.

Refrigerant tubing

Dielectric union: unique adapter is applied to separate the two dissimilar metals by inserting an elastomeric rubber gasket in between. As If two different metals come in contact with each other, an electrolytic reaction begins, where water serves as the electrolyte. So, the metals will corrode. This process is called galvanic corrosion.

Line Test Pressure

	R-134a	R-407C	R-410A
Suction Lines for Air-Cond tioning	793 kPa	1586 kPa	2068 kPa.
Suction Lines for Heat Pump	1551 kPa	2620 kPa	3689 kPa.
Hot-Gas and Liquid Lines	1551 kPa	2620 kPa	3689 kPa.

Steam Piping

Install the following pipe attachments:

a.Adjustable steel clevis hangers for individual horizontal piping less than 6 m long.
b.Adjustable roller hangers and spring hangers for individual horizontal piping 6 m or longer.
c.Pipe Roller used for multiple horizontal piping 6 m or longer, supported on a trapeze.
d.Spring hangers to support vertical runs.
e.Install hangers with the following maximum spacing and minimum rod sizes:

Pipe Size	Spacing	Rod
DN 20	2.1 m	16 mm
DN 25	2.1 m	16 mm
DN 32	2.7 m	19 mm
DN 40	2.7 m	19 mm
DN 50	3.0 m	19 mm
DN 65	3.4 m	19 mm
DN 75	3.7 m	19 mm
DN 100	3.7 m	19 mm
DN 150	3.7 m	22 mm
DN 200	3.0 m	22 mm
DN 250	1.8 m	25 mm
DN 300	1.2 m	25 mm

Vertical runs at roof, at each floor, and at 3-m intervals between floors.

UPVC Piping

Pipe Diameter	Maximum Support Spacing		Minimum size of hanger Rod (mm)
	Horizontal Pipe (Cm)	Vertical Pipe (Cm)	
15 mm	60	120	10
20 mm	70	140	10
25 mm	75	150	10
32 mm	80	160	10
40 mm	90	180	10
50 mm	105	210	10
75 mm	135	270	13
100 mm	150	300	16
150 mm	180	360	16
200 mm Or Larger	215	360	16

Maximum Support spacing for Schedule 40 CPV Piping (in feet)

Temperature (°f)	0.5"	0.75"	1"	1.25"	2"	2.5"	3"	4"	6"	8"	10"
73	5	5	5.5	5.5	6	7	7	7.5	8.5	9.5	10.5
100	4.5	5	5.5	5.5	6	7	7	7.5	8	9	10
120	4.5	4.5	5	5.5	5.5	6.5	7	7	7.5	8.5	9.5
140	4	4	4.5	5	5	6	6	6.5	7	7.5	8
160	2.5	2.5	3	3	3.5	4	4	4.5	5	5.5	6
180	2.5	2.5	2.5	3	3	3.5	3.5	4	4.5	5	5.5

Maximum Distance Between Hangers (ft-in) As per NFPA

	Nominal Pipe Size (in.)											
	¾	*1*	*1¼*	*1½*	*2*	*2½*	*3*	*3½*	*4*	*5*	*6*	*8*
Steel pipe except threaded lightwall	NA	12-0	12-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0	15-0
Threaded lightwall steel pipe	NA	12-0	12-0	12-0	12-0	12-0	12-0	NA	NA	NA	NA	NA
Copper tube	8-0	8-0	10-0	10-0	12-0	12-0	12-0	15-0	15-0	15-0	15-0	15-0
CPVC	5-6	6-0	6-6	7-0	8-0	9-0	10-0	NA	NA	NA	NA	NA
Polybutylene (IPS)	NA	3-9	4-7	5-0	5-11	NA	NA	NA	NA	NA	NA	NA
Polybutylene (CTS)	2-11	3-4	3-11	4-5	5-5	NA	NA	NA	NA	NA	NA	NA
Ductile Iron Pipe	NA	NA	NA	NA	NA	NA	15-0	NA	15-0	NA	15-0	15-0

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.
Note: IPS = iron pipe size; CTS = copper tube size.
Source: NFPA 13, *Standard for the Installation of Sprinkler Systems.*

ASHRAE Standard 90.1 Minimum Pipe Insulation Thickness Recommendations

Minimum Duct Insulation R-Value

Climate zone	Duct location		
	Exterior[b]	Unconditioned Space and Buried Ducts	Indirectly conditioned Space[c,d]
Supply and Return Ducts for Heating and cooling			
0 to 4	R-1.41	R-1.06	R-0.34
5 to 8	R-2.12	R-1.06	R-0.34
Supply and Return ducts for heating only			
0 to 1	None	None	None
2 to 4	R-1.06	R-1.06	R-0.34
5 to 8	R-2.12	R-1.06	R-034
Supply and Return Ducts for cooling only			
0 to 6	R-1.41	R-1.06	R-0.34
7 to 8	R-0.34	R-0.34	R-0.34

Minimum Piping Insulation thickness Heating and Hot- Water Systems (Steam,Steam Condensate,Hot-Water Heating and Domestic Water Systems)

Fluid Operating Temperature Range (°c) and usage	Insulation Conductivity		>=Nominal Pipe or Toube size,mm				
	Condctivity,W (m.°c)	Mean Rating Temperature,°c	<25	25 to <40	40 to <100	100 to <200	>=200
			Insulation Thickness,mm				
>177	0.046 to 0.049	121	115	125	125	125	125
122 to 177	0.042 to 0.046	93	80	100	115	115	115
94 to 121	0.039 to 0.043	66	65	65	80	80	80
61 to 93	0.036 to 0.042	52	40	40	50	50	50
41 to 60	0.032 to 0.040	38	25	25	40	40	40

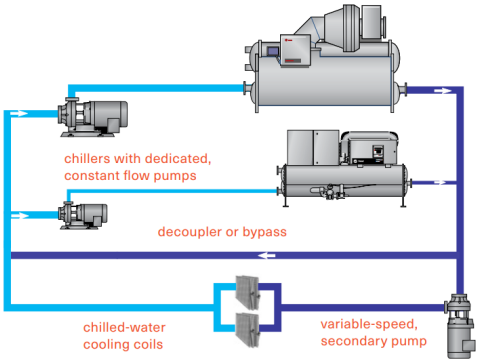
Minimum Piping Insulation thickness Cooling Systems (Chilled Water, Brine, and Refrigerant)

Fluid Operating Temperature Range (°c) and usage	Insulation Conductivity		Nominal Pipe or Toube size,mm				
	Condctivity,W (m.°c)	Mean Rating Temperature,°c	<25	25 to <40	40 to <100	100 to <200	>=200
			Insulation Thickness,mm				
4 to 16	0.030 to 0.039	24	13	13	25	25	25
<4	0.029 to 0.037	10	13	25	25	25	40

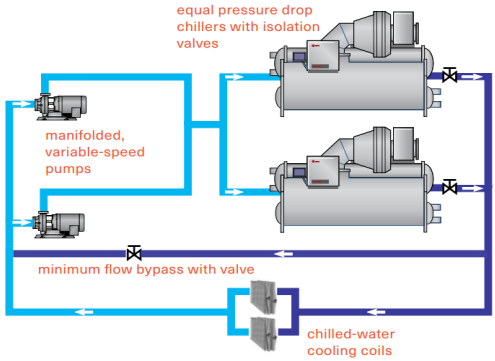
Low-Delta-Syndrome

All chilled-water systems with two-way valves experience low-delta-T syndrome. Low-delta-T syndrome is a reduction in chilled-water temperature range independent of load change. It is a system problem causing the energy consumption of variable speed-driven pumps and chiller plants to be increased.
SelectingPiperoutingConfigurationManychoicesareavailabletoovercomeLow-Delta-TSyndrome,reducecostandenergycon-sumptionincludingdecoupledversusvariable-primaryflow,parallelversusserieschillers,andhowtosizeandsitebypasslines.

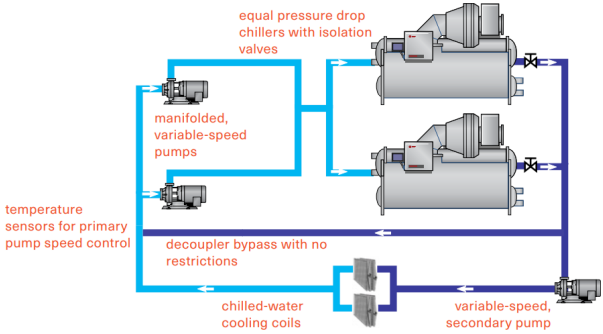
Decoupled: Constant Primary Flow (CPF)



Variable-Primary Flow (VPF)



Variable-Primary, Variable-Secondary Flow (VPVS)

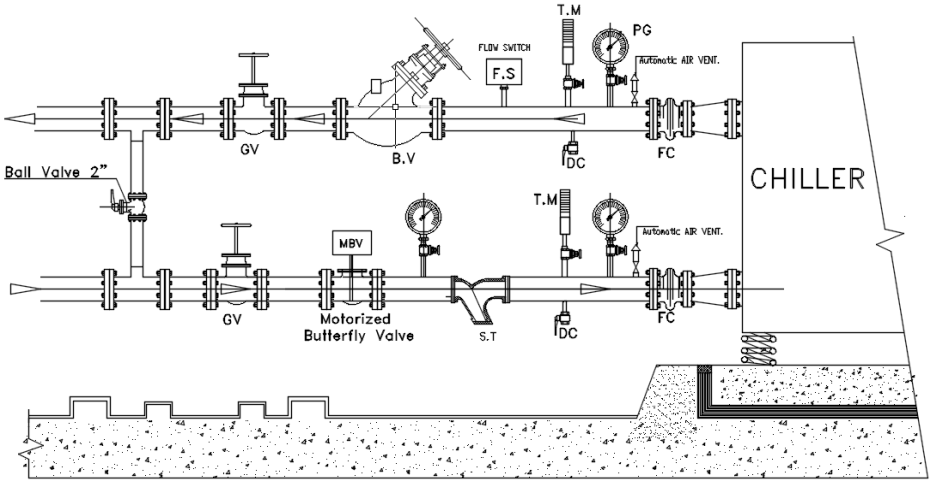


Energy Impacts of Chilled-Wa ter-Piping Configuration

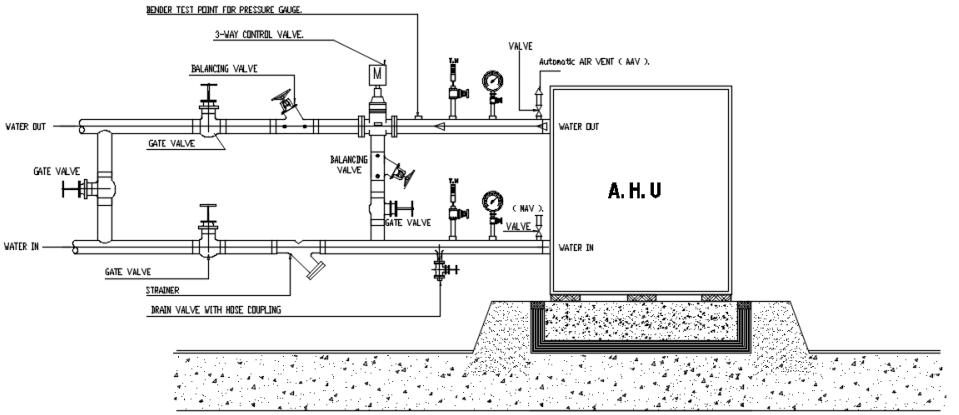
	CPF	P/S	VPF
Pump energy	(Base Case)	50 to 60 percent less	60 to 75 percent less
Delta-T mitigation	Does not apply	Higher energy	less energy
Valve type	Three-way	Two-way	Two-way
Installed cost	(Base Case)	10 percent higher	5 percent higher
Control complexity	Simple	Simple	can be complex
Plant space	(Base Case)	Larger	same as base case

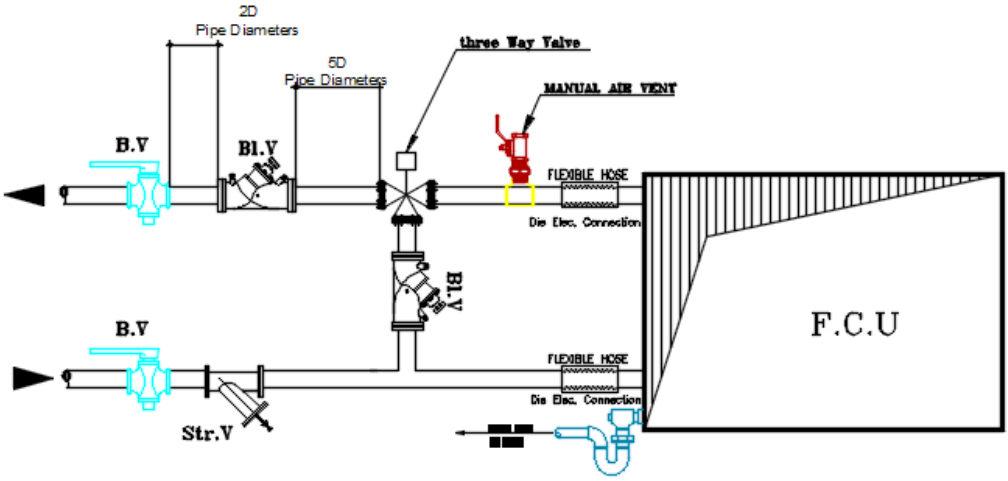
Hockups

The AHUs and FCUs can be controlled by applying 2-way or 3-way valves.For small pipes(2" or less) threaded valved should be used.

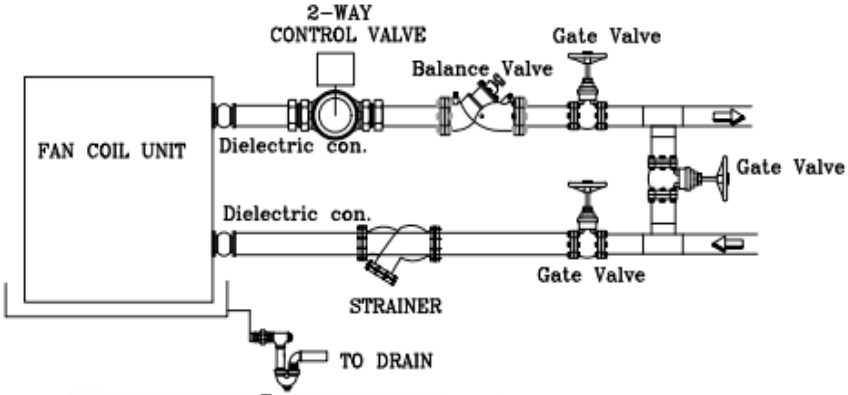


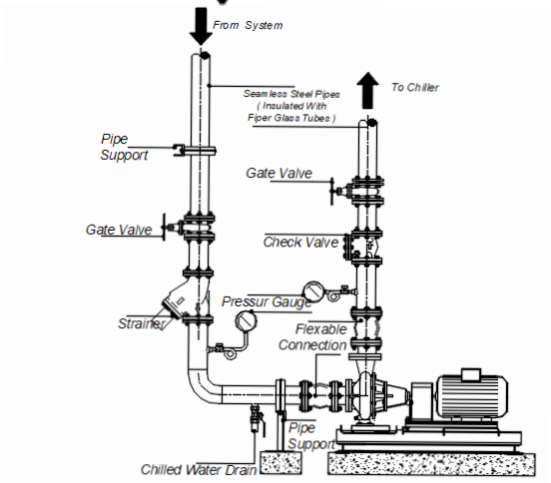
TYP. CHILLER CONNECTION DETAIL





F.C.U HOOK UP DETAILS





Chilled Water Pump Hook Up Details (N.T.S.)

About This Book

Answers you need, when you ask for them,When you need to check specs, confirm measurements, or make a quick metric conversion on the job, find the answers quickly and easily right in your pocket. This HVAC Pocket Reference was assembled to aid the beginning and experienced engineer in the design of HVAC systems. In addition, you may find this manual useful as a quick design reference guide and a teaching tool. It provides access to frequently needed information about Cooling Loads, Infiltration, Ventilation, Duct Sizing, Pressure drop Estimating, Piping System Sizing and Configuration.