Example 2: USING THE HVAC DESIGN REVIEW FORM

Load Calculation: **Manual J Abridged Edition**
Equipment Selection: **Heat Pump**

The form below illustrates the Manual J Abridged Edition (AE) forms and the equipment selection process for a heat pump. The Manual JAE condenses the basic elements of the load calculation into a functional procedure to promote comprehension in students. Manual J1AE load calculations are valid however; they must meet all of the requirements on the Alternative Abridged Edition Check List (page 6).

ACCA Air Conditioning Contractors of America

Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts)

Form RPER 1.01 8 Mar 10

County, Town, Municipality, Jurisdiction Header Information

Contractor: ABC Heating and Air Conditioning Company
Mechanical License #: MCL# 123456789
Building Plan #: Model P54321-987, dated 13 June 2010
Home Address (Street or Lot#, Block, Subdivision): 123 Elm Street, Houston TX

REQUIRED ATTACHMENTS[1]	ATTACHED
Manual J1 Form (and supporting worksheets):	Yes ☐ No ☒
or MJ1AE Form[2] (and supporting worksheets):	Yes ☒ No ☐
OEM performance data (heating, cooling, blower):	Yes ☒ No ☐
Manual D Friction Rate Worksheet:	Yes ☒ No ☐
Duct distribution system sketch:	Yes ☒ No ☐

HVAC LOAD CALCULATION (IRC M1401.3)

Design Conditions

Winter Design Conditions

Outdoor temperature	(1) 31	°F
Indoor temperature	(2) 70	°F
Total heat loss	(14) 28,829	Btu

Summer Design Conditions

Outdoor temperature	(3) 94	°F
Indoor temperature	(4) 75	°F
Grains difference	(5) 51 Δ (6) @ 50	% Rh
Sensible heat gain	(15) 23,918	Btu
Latent heat gain	(16) 4,364	Btu
Total heat gain	(17) 28,272	Btu

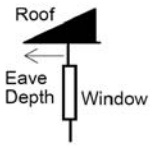
Building Construction Information

Building

Orientation (Front door faces)	(7) South	(North, East, West, South, Northeast, Northwest, Southeast, Southwest)
Number of bedrooms	(8) 2	
Conditioned floor area	(9) 1,200	Sq Ft
Number of occupants	(10) 3	

Windows

Eave overhang depth	(11) 1.5	Ft
Internal shade	(12) Blinds, light, 45 Angle	(Blinds, drapes, etc)
Number of skylights	(13) 0	



HVAC EQUIPMENT SELECTION (IRC M1401.3)

Heating Equipment Data

Equipment type (Furnace, Heat pump, Boiler, etc.)	(18) Fan Coil/Air handler	
Model	(19) XYZ FCA 036 & 5KW Heat	
Heating output capacity (Heat pumps - capacity at winter design outdoor conditions)	(20) 15,500	Btu
Auxiliary heat output capacity	(21) 17,065	Btu

Cooling Equipment Data

Equipment type (Air Conditioner, Heat pump, etc)	(22) Heatpump	
Model	(23) XYZ 030 Heatpump	
Sensible cooling capacity	(24) 21,200	Btu
Latent cooling capacity	(25) 7,500	Btu
Total cooling capacity	(26) 28,700	Btu

Blower Data

Heating CFM	(27) 1,000	CFM
Cooling CFM	(28) 1,000	CFM

HVAC DUCT DISTRIBUTION SYSTEM DESIGN (IRC M1601.1)

Design airflow	(29) 1,000	CFM	Longest supply duct:	(33) 288	Ft
External Static Pressure (ESP)	(30) 0.58	IWC	Longest return duct:	(34) 107	Ft
Component Pressure Losses (CPL)	(31) 0.27	IWC	**Total Effective Length (TEL)**	(35) 388	Ft
Available Static Pressure (ASP) (ASP = ESP - CPL)	(32) 0.31	IWC	**Friction Rate:** (Friction Rate = (ASP × 100) ÷ TEL)	(36) 0.08	IWC

Duct Materials Used (circle)
Trunk Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)
Sheet metal (insulated R-8) (37)
Branch Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)
Flex duct (insulated R-8) (38)

I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above, I understand the claims made on these forms will be subject to review and verification.

Contractor's Printed Name: Bartholomew J. Simpson Date: 1 April 2010
Contractor's Signature: Bart Simpson

Reserved for use by County, Town, Municipality, or Authority having jurisdiction.

[1] The AHJ shall have the discretion to accept Required Attachments printed from approved ACCA software vendors, see list on page 2 of instructions.
[2] If abridged version of Manual J is used for load calculation, then verify residence meets requirements, see Abridged Edition Checklist on page 13 of instructions.

Part I: Manual JAE – Forms used for Load Calculations

FORM J1ae ABRIDGED EDITION OF MANUAL J, 8TH EDITION							1) Room Name L, H & W in decimal feet and gross SqFt areas		Block Load Length	Height or Width	Gross Area
Project: Vatilo Residence			**Location:** Houston, TX (airport)								
ACCA	Indoor db Heating	70	Latitude	29	DR	Medium	2) Exposed Wall		140	8	1120
	Indoor db Cooling	75	99% db	31	HTD	39	3) Partition		18	8	144
	Indoor RH Cooling	50%	1% db	94	CTD	19	4) Floor		40	30	1200
	Elevation	96	Grains	51	ACF	1.00	5) Ceiling		Slope >	0	1200
				Construction Number Direction & Details			Heating HTM	Cooling HTM	Net Area	Btuh Heating	Btuh Cooling
6A	Windows & Glass Doors	a	1E-c-mb (North-B1)				24.57	16.00	24.00	590	384
	Load Area (SqFt) = 168.08	b	1D-c-mb (East A1)				25.35	39.93	36.00	913	1437
		c	1D-c-mb (West C1; glass door)				25.35	46.00	44.33	1124	2039
		d	1D-c-mb (West A2)				25.35	39.93	15.75	399	629
		e	1D-c-mb (South A1)				25.35	14.40	36.00	913	518
		f	1E-c-mb (South B2)				24.57	24.00	12.00	295	288
		g									
		h									
		i									
		j									
		k									
		l									
6B	Skylights	a									
	Load Area (SqFt) = 0.00	b									
		c									
		d									
7	Wood & Metal Doors	a	11N metal door (North)				13.65	10.85	21.00	287	228
	Load Area (SqFt) = 42.00	b	11N metal door (South)				13.65	10.85	21.00	287	228
		c									
		d									
8	Above Grade Walls	a	12C-2sw-stucco North				3.16	1.98	152	480	302
	Load Area (SqFt) = 787	b	12C-2sw-stucco East				3.16	1.98	204	644	405
		c	12C-2sw-stucco South				3.16	1.98	251	793	498
		d	12C-2sw-stucco West				3.16	1.98	180	568	357
		e									
		f									
	Partition Walls	g	12C-2sw-stucco Garage				3.16	1.25	123	389	153
	Load Area (SqFt) = 123	h									
9	Below Grade Walls	a									
	Load Area (SqFt) = 0	b									
10	Ceilings	a	16B-30ad				1.25	1.76	1200	1498	2112
	Load Area (SqFt) = 1200	b									
		c									
	Partition Ceilings	d									
	Load Area (SqFt) = 0	e									
11A	Passive Floors	a	22A-ph (slab, no insulation)				52.96		140	7415	
	Load Area (SqFt) = 1200	b									
	Use feet of exposed edge for slab	c									
	Partition Floors	d									
	Load Area (SqFt) = 0	e									
12	Infiltration 1120	a	Envelope Leakage		Average		Infilt Cfm for Heating		72	3089	769
	Gross exposed wall area for WAR	b	No of Fireplaces		None		Infilt Cfm for Cooling		37		
13	Internal Gains	a	Number of bedrooms		2		# Occupants >		3		690
	One occupant = 230 sensible Btuh	b	Appliances (1200 Btuh or 2400 Btuh)								1200
14	**Sub Totals** (sum lines 6A through 13)									19682	12238
15	**Duct Loss / Gain:**	7B-AE, R4, 0.35 / 0.70, with duct surface area adjustment					Factors >	0.46	0.81	9147	9973
16	**Ventilation**	Maximum ventilation Cfm for MJ8ae is 50						Cfm for this job >	None		
19	**Blower Heat Gain**	Manufacturer's performance data has blower heat discount (1,707 if no, 0 if yes)									1707
20	**Total Sensible Loss or Gain** (sum lines 14 through 20)									28829	23918

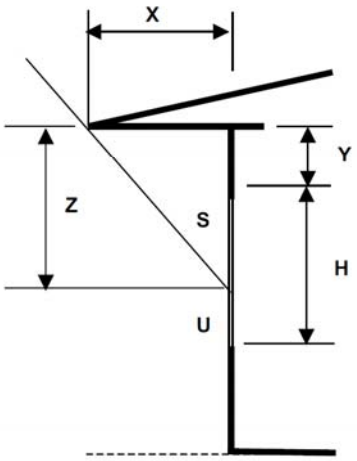
21		
	A) Latent Infiltration Gain (Btuh)	1276
	B) Latent for Occupants (One occupant = 200 Btuh)	600
	C) Latent for Plants (Small = 10, Med = 20, Large = 30)	
	D) Latent for Duct in Unconditioned Space	2488
	E) Latent Ventilation Gain	
	F) Total Latent Gain (Btuh)	4364

Worksheet B: Heating and Cooling HTM and Load Area for Windows (flat, bay or garden) **and Glass Doors** (hinged, sliding or French)

HTD	CTD	T3 CTD

Round CTD value for Table 3 lookup; use + 1 or - 1; or +2 or -2; as required (16 = 15; 17 = 15; 18 = 20; 19 = 20)

Form J1ae, item 6A	Northerly Direction or Obviously Shaded by Overhang										
Line ID (a, b, c, … etc.)	a						b		c		
Direction glass faces	North						East		West		
Number of panes	2						2		2		
Frame type (w, m. mb, v)	mb						mb		mb		
1) Table 2A construction number **To J1ae -->**	1E-c-mb (North-B1)						1D-c-mb (East A1)		1D-c-mb (West glass		
2) Table 2A U-value	0.63						0.65		0.65		
3) Unadjusted heating HTM = U x HTD	24.57						25.35		25.35		
4) Heating HTM adjustment (see Note 1)	1.00						1.00		1.00		
5) Adjusted heating HTM (L3 x L4) **To J1ae -->**	24.57						25.35		25.35		
6) Cooling HTM from Table 3A (default = blinds @ 45 deg) (12)	16						46		46		
7) Cooling HTM adjustment (see Note 2)	1.00						0.90		1.00		
8) Adjusted C-HTM (L6 x L7) **N, NE, NW to J1ae -->**	16.00						41.40		46.00		
9) Area of opening (SqFt) for one unit	24.00						18.00		44.33		
10) Number of identical assemblies	1						2		1		
11) Net area of identical assemblies (L9 x L10) **To J1ae -->**	24.00						36.00		44.33		



If S is negative or zero, stop! Then copy the line 8 HTM to line 26

If S > H, jump to line 19; then copy the line 21 HTM to line 26

Internal shade same as used for Line 6

Overhang (OH) Adjustment

12) Opening height (H) in feet	4.50		6.33
13) Overhang length (X) in feet (11)	1.50		1.50
14) SLM value for local latitude	0.83		0.83
15) Shade line to OH (Z) = L13 x L14	1.245		1.245
16) Distance below OH (Y)	1.00		1.50
17) Shaded height (S) = L15 - L16	0.245		-0.25
18) Unshaded height (U) = L12 - L17	4.255		
19) North HTM from Table 3A	16		
20) HTM adjustment (copy line 7)	0.90		
21) Adjusted North HTM (L19 x L20)	14.40		
22) Shaded glass factor = L17 / L12	0.054		
23) Unshaded glass factor = L18 / L12	0.946		
24) Shaded HTM = L21 x L22	0.78		
25) Unshaded HTM = L8 x L23	39.15		
To J1ae > 26) Effective HTM = L24 + L25	39.93		46.00

	SLM Values for North Latitudes					
Latitude	**25**	**30**	**35**	**40**	**45**	**50**
E or W	0.83	0.83	0.82	0.81	0.80	0.79
SE or SW	1.89	1.63	1.41	1.25	1.13	1.10
South	10.10	5.40	3.53	2.60	2.05	1.70

Note 1: Default = 1.0; Bay window = 1.15; Garden window = 2.75; French door = 0.70

Note 2: Default = 1.0; Insect screen = 0.90; Bay window = 1.15; Garden winc

Part II: Manual S – Equipment Expanded Performance Data

XYZ Performance Data

Model 030 HP (Fan Coil FC030) @ 1,000 CFM (27) (28)

OD Dry Bulb (F)	Indoor Entering Wet Bulb (F) (23)	Total Capacity (22)	Sensible Capacity at Entering Dry Bulb Temperature (F) (18) (19)			
			72	75	78	80
85	59	28,400	22,600	25,300	27,800	29,400
	63	29,900	18,800	21,600	24,300	26,100
	67	32,100	15,100	17,900	20,700	22,600
	71	34,700	11,400	14,200	17,000	18,900
(3) 95	(5) (6) 63	(26) 28,700	22,200 18,500	(25) 21,200	27,400 23,900	28,300 25,700
	67	30,800	14,700	17,500	20,400	22,200
	71	33,300	11,000	13,700	16,600	18,500
105	59	26,200	21,900	24,500	27,100	27,200
	63	27,600	18,100	20,900	23,600	25,400
	67	29,700	14,300	17,200	20,000	21,800
	71	32,100	10,600	13,300	16,200	18,100

OD Dry Bulb – Outdoor Dry Bulb, the outdoor temperature.

Correction Factors for other Airflows			
	Airflow	Total Capacity	Sensible Capacity
Low	875	0.98	0.93
High	1125	1.02	1.06
Multiply rated capacity data by factor.			

XYZ 030 Heating Performance Data

O.D. TEMP. F.	HEATING CAPACITY MBH AT INDOOR DRY BULB TEMP. 70	75	80	TOTAL POWER IN KILOWATTS AT INDOOR DRY BULB TEMP. 70	75	80
2	7.7	7.6	7.6	1.39	1.43	1.47
7	9.2	9.1	9.0	1.42	1.47	1.51
12	10.7	10.5	10.5	1.46	1.50	1.55
17	12.1	12.0	11.9	1.50	1.54	1.59
22	13.3	13.1	13.0	1.54	1.58	1.63
27	14.4	14.2	14.1	1.57	1.62	1.67
(1) 32	(20) 15.5	15.4	15.2	1.61	1.66	1.71
37	17.0	16.8	16.7	1.65	1.70	1.75
42	19.0	18.8	18.6	1.68	1.73	1.78
47	21.0	20.8	20.6	1.71	1.76	1.81
52	22.5	22.3	22.1	1.75	1.80	1.85
57	24.0	23.7	23.5	1.78	1.83	1.89
62	25.4	25.2	24.9	1.82	1.87	1.93
67	26.9	26.6	26.4	1.85	1.91	1.96
72	28.4	28.1	27.8	1.89	1.94	2.00

CORRECTION FACTORS FOR OTHER AIRFLOWS (MULTIPLY DATA BY FACTOR)			
	AIRFLOW	TOTAL CAPACITY	SENSIBLE CAPACITY
LOW	700	0.98	0.97
HIGH	900	1.01	1.02

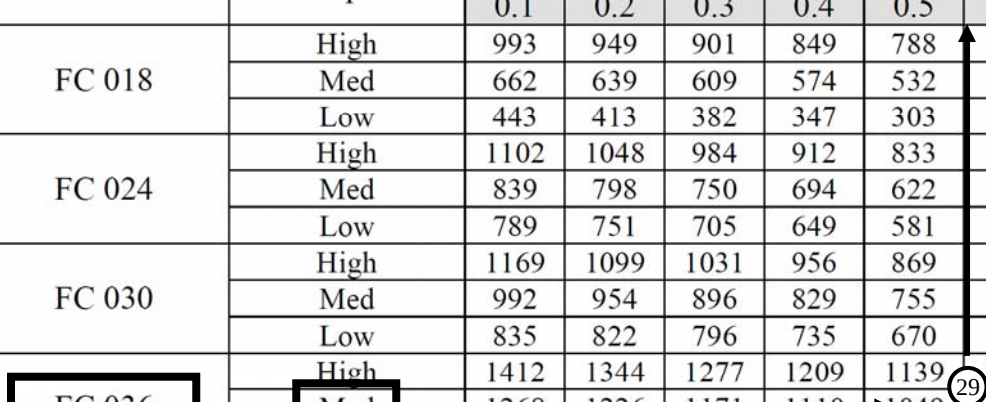
Part III: Manual D Duct Sizing

The FC 036 blower assembly can deliver approximately 1,000 CFM on Medium fan speed at 0.58iwc external static pressure (ESP), see #20 below. This airflow is dependent on a few factors that will come into play on the Friction Rater Worksheet. For more explanation, see the discussion about "Adjusting Design Airflow" (page 7) in "Understanding and Using the HVAC System Design Review Form."

XYZ Company Fan Coil Blower Performance Data

Air Delivery – CFM (wet coil, no heaters, with filter‡)

Model	Fan Speed*	External Static Pressure (inches water column)								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
FC 018	High	993	949	901	849	788	711	608	467	–
	Med	662	639	609	574	532	475	391	266	–
	Low	443	413	382	347	303	245	167	–	–
FC 024	High	1102	1048	984	912	833	738	614	442	197
	Med	839	798	750	694	622	532	416	268	–
	Low	789	751	705	649	581	496	385	240	–
FC 030	High	1169	1099	1031	956	869	769	659	542	429
	Med	992	954	896	829	755	672	569	432	239
	Low	835	822	796	735	670	590	486	342	141
FC 036	High	1412	1344	1277	1209	1139	1065	988	907	823
	Med	~~1268~~	~~1226~~	~~1171~~	~~1110~~	1049	987	916	827	702
	Low	1082	1055	1013	965	915	862	799	713	584
FC 042	High	1715	1609	1529	1458	1385	1303	1210	1109	1009
	Med	1542	1449	1380	1314	1240	1158	1078	1018	1010
	Low	1316	1237	1177	1123	1064	1000	932	870	829



* At 230 Volts horizontal installation, multiply value by 0.978 for vertical airflow value (with factory supplied condensate pan).
‡ Airflow shown is for horizontal installation with factory supplied 1" washable filter (0.05 iwc).

Friction Rate Worksheet

Step 1) Manufacturer's Blower Data

External static pressure (ESP) = (30) 0.58 IWC Cfm = (29) 1,000

Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	
Electric resistance heating	0.04
Hot water coil	
Heat exchanger	
Low efficiency filter	- 0.05
High or mid-efficiency filter	0.19
Electronic filter	
Humidifier	
Supply outlet	0.03
Return grille	0.03
Balancing damper	0.03
UV lights or other device	
(31) Total component losses (CPL)	0.27 IWC

Step 3) Available Static Pressure (ASP)

ASP = (ESP - CPL) = (0.58 - 0.27) = (32) 0.31 IWC

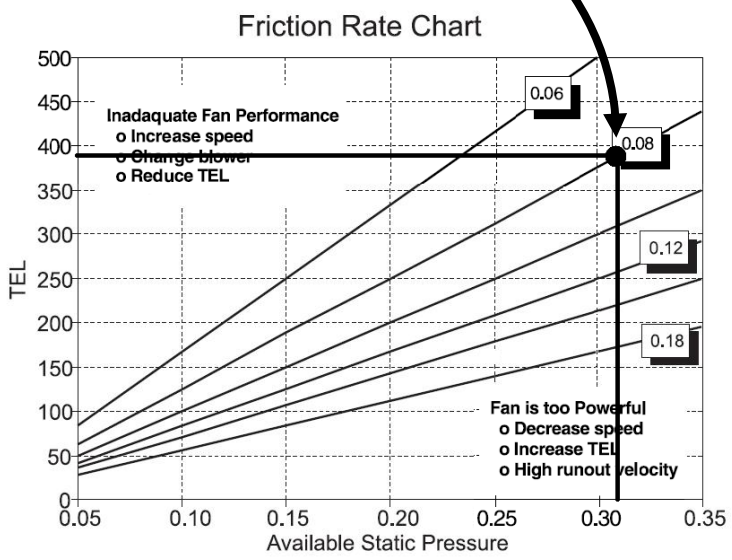
Step 4) Total Effective Length (TEL)

(33) Supply-side TEL + (34) Return-side TEL = (278 + 110) = (35) 388 Feet

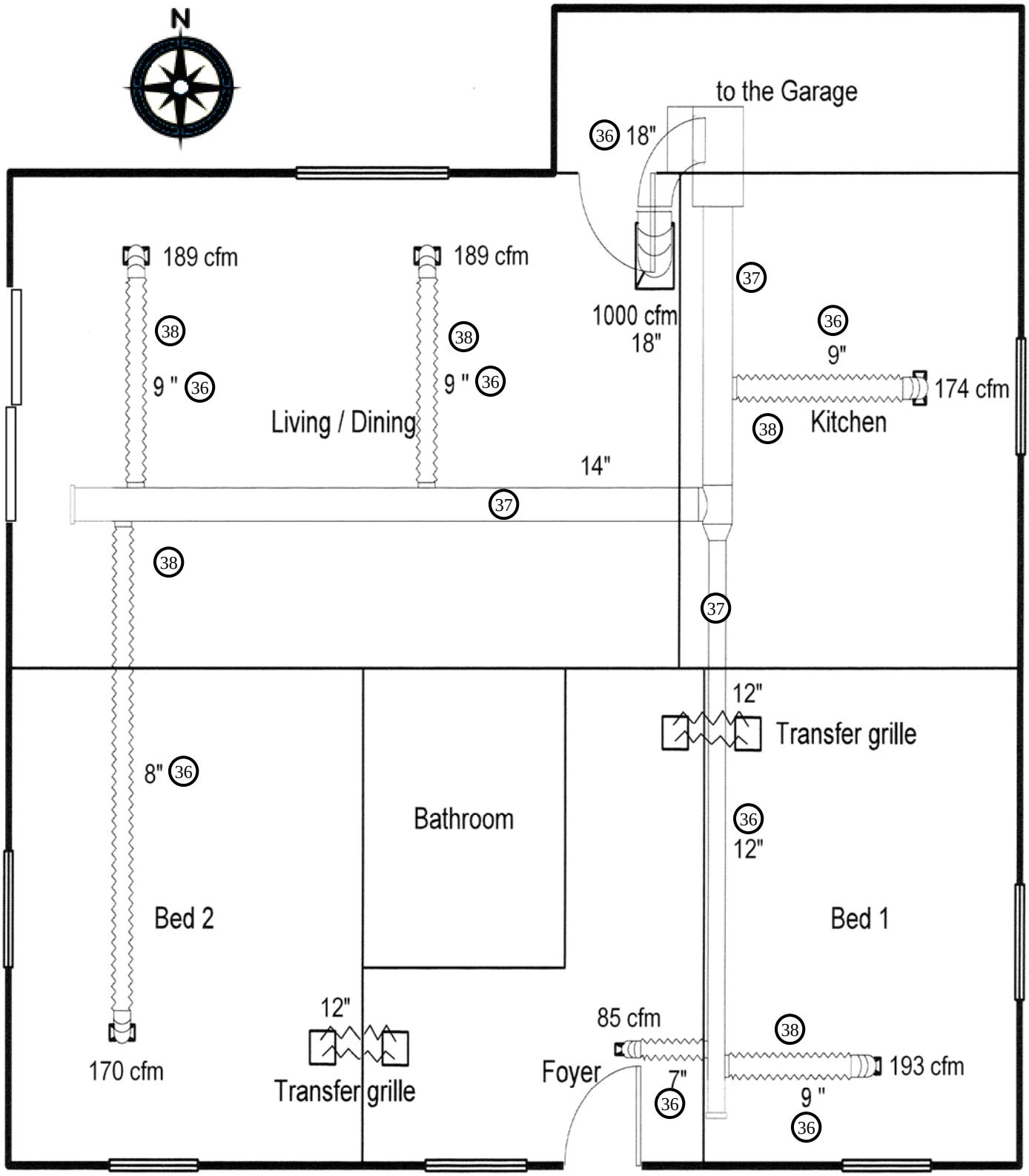
Step 5) Friction Rate Design Value (FR)

(36) FR value from friction rate chart = 0.08 IWC/100

$$FR = \frac{ASP \times 100}{TEL}$$



Duct Sketch


N
to the Garage
36 18"
189 cfm
189 cfm
38
9 " 36
38
9 " 36
Living / Dining
1000 cfm
18"
37
36
9"
174 cfm
38
Kitchen
14"
37
38
37
12"
Transfer grille
8" 36
Bathroom
36
12"
Bed 2
Bed 1
12"
Transfer grille
170 cfm
85 cfm
38
Foyer
7"
36
193 cfm
9 "
36

Alternative Abridged Edition Check List	
The abridged procedure was used, I have initialed next to each block to indicate this dwelling meets each criteria.	
	ONLY a single family detached dwelling.
	HVAC system is a central, single-zone, constant volume system.
	NO radiant heating system.
	NO ventilation heat exchanger (ERV or HRV) or a ventilating dehumidifier.
	ONLY engineered ventilation allowed is provided by piping outdoor air to the return side of the duct sys tem (pressurization effect on infiltration is ignored).
	The indoor design conditions are: Heating 70 °F; Cooling 75 db °F and 45%, 50% or 55% RH.
	ONLY outdoor design conditions equal to the values in Table 1A were used.
	TOTAL window area (including glass doors and skylight area) does not exceed 15 percent of the associated floor area.
	The windows are equitably distributed around all sides of the dwelling — the dwelling has sufficient exposure diversity.
	NO Low-e, tinted, reflective, or special glass (All windows, skylights, and glass doors must be clear 1-pane, 2-pane or 3-pane glass)
	ALL skylights are flat. NO skylight light shafts or internal shade.
	ALL windows' internal shade factor is a medium-color blind with slats at 45 degrees.
	ALL U-values and SHGC values for all windows, skylights, and glass doors are from Table 3A and 3C.
	ALL purpose-built daylight windows and skylights have no internal shade.
	ALL windows and glass doors are calculated with applicable bug screen, French door, and projection adjustments.
	NO glass external sun screens.
	ALL windows and glass doors are calculated with applicable overhang adjustments.
	ALL above grade walls are wood frame walls or empty-core block walls (no metal framing, no filled core block).
	ALL exterior finish is brick, stucco, or siding.
	ONLY gypsum board was used for the interior finish.
	ALL below grade walls are empty-core block walls (board insulation; framing and blanket insulation).
	ALL framing is wood (not metal).
	ONLY a dark shingle roof over an attic, a beam ceiling or a roof-joist ceiling.
	ONLY attic or attic knee wall space (when applicable) vented to FHA standards, with no radiant barrier.
	ONLY slab floors with no edge insulation (or 3 feet of vertical insulation that covers the edge). NO insulation below basement floors slab, no sensitivity to width.
	NO insulation under floors over a closed space or on the walls of the closed space.
	Floors over a closed space are insensitive to the tightness of the closed space.
	ONLY infiltration load estimates based on Table 5A (three or four exposures, class 4 wind shielding, no blower door
	ONLY a sensible appliance load of 1,200 or 2,400 Btuh
	ONLY number of occupants is the number of bedrooms plus one.
	ONLY allowed duct systems (when applicable) are: a. installed in one horizontal plane; b. entirely in a conditioned
	ONLY one of the following duct runs were used: a. An attic installed radial or spider pattern supply system (supplies in room centers) and returns (large return close to air handler or return in closet door); OR b. A trunk and branch supply system in the attic (supplies near inside walls; return riser in floor to ceiling chase); OR c. A trunk and branch supply system in a closed crawlspace or unconditioned basement.
	ONLY the duct leakage rate of R/A=0.12 S./A = 0.24 was used, unless proven by a leakage test.
	ONLY the following duct insulation: R-2, R-4, R-6, or R-8.
	ONLY blower heat adjustment is 500 Watts, if manufacturer's performance data is not discounted for blower heat.
Note: The abridged edition of ***Manual J*** (MJ8ae) shall ONLY be used to estimate heating and cooling loads for dwellings which are totally compatible (100 percent) with this checklist and the descriptions and caveats provided by Appendix 2 and 3. The full version of ***Manual J*** will be used for all other scenarios.	