THE HVAC DESIGN REVIEW FORM: Example 1:

Load Calculation: **Manual J**
Equipment Selection: **Furnace and Air Conditioner**

This example illustrates a permit application packet when the HVAC Contractor used the full Manual J procedure, and when the installed equipment is a gas furnace and an air conditioner. The circled numbers on HVAC Systems Design Review Form correspond to the description in the instructions and to the locations where the information can be found on the submitted attachments.

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 P987654321, dated 1 June 2010
Home Address (Street or Lot#, Block, Subdivision): 123 Elm Street, Ames, Iowa

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

(1) Outdoor temperature	-6	°F
(2) Indoor temperature	70	°F
(13) Total heat loss	59,326	Btu

Summer Design Conditions

(3) Outdoor temperature	90	°F
(4) Indoor temperature	75	°F
(5) Grains difference	38 (6) Gr @ 50	% Rh
(15) Sensible heat gain	23,807	Btu
(16) Latent heat gain	4,771	Btu
(17) Total heat gain	28,578	Btu

Building Construction Information

Building

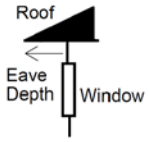
(7) Orientation (Front door faces)	North	
(8) Number of bedrooms	3	
(9) Conditioned floor area	1,792	Sq Ft
(10) Number of occupants	4	

North, East, West, South, Northeast, Northwest, Southeast, Southwest

Windows

(11) Eave overhang depth	2	Ft
(12) Internal shading	Blinds, light, 45 Angle	
(13) Number of skylights	2	

Blinds, drapes, etc



HVAC EQUIPMENT SELECTION (IRC M1401.3)

Heating Equipment Data

(18) Equipment type	Gas Furnace	
(19) Model	XYZ 080-14	
(20) Heating output capacity	64,000	Btu
(21) Auxiliary heat output capacity	N/A	Btu

Furnace, Heat pump, Boiler, etc.
Heat pumps - capacity at winter design outdoor conditions

Cooling Equipment Data

(22) Equipment type	Air Conditioner	
(23) Model	XYZ 030 Condenser 030 Coil	
(24) Sensible cooling capacity	21,400	Btu
(25) Latent cooling capacity	7,900	Btu
(26) Total cooling capacity	29,300	Btu

Air Conditioner, Heat pump, etc

Blower Data

(27) Heating CFM	1,185	CFM
(28) Cooling CFM	1,000	CFM

HVAC DUCT DISTRIBUTION SYSTEM DESIGN (IRC M1601.1)

(29) Design airflow	1,117	CFM	(33) Longest supply duct:	278	Ft
(30) External Static Pressure (ESP)	0.75	IWC	(34) Longest return duct:	110	Ft
(31) Component Pressure Losses (CPL)	0.40	IWC	(35) Total Effective Length (TEL)	388	Ft
(32) Available Static Pressure (ASP)	0.35	IWC	(36) Friction Rate:	0.09	IWC

ASP = ESP - CPL
Friction Rate = (ASP × 100) ÷ TEL

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

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.

Figure 1: Sample Completed HVAC System Design Review Form – Manual J/Gas Furnace & A/C

Part I: Manual J – Forms used for Load Calculations

Worksheet A
Location and Design Conditions

State: Iowa	**City:** Ames	**Elevation** = 955 Ft	**Latitude** = 42 Degrees North
Indoor Conditions, Heating:	**DB** = 70 °F (2) 20%	**Indoor Conditions, Cooling:**	**DB** = 75 °F (4) **RH** = 50% (6)
Table 1 Conditions	**99% DB** = -6 °F (1)	**1% DB** = 90 °F (3)	**Grains Difference** = 38 (5) **Daily Range** = Medium
Design Temperature Differences	**HTD** = 70 - (-6) = 76 °F	**CTD** = 90 - 75 = 15 °F	

Form J1

1	**Name of Room** Smith Residence					**Entire House**									
2	**Running Feet of Exposed Wall**					2 x (56 + 32) = 176									
3	**Ceiling Height (Ft) and Gross Wall Area (SqFt)**					8 & 10	1,408 + 696 = 2,104								
4	**Room Dimensions (Ft) and Floor Plan Area (SqFt)**					56 x 32	(9) 1,792								
5	**Ceiling Slope (Deg.) and Gross Ceiling Area (SqFt)**					0	1,792								
Type of Exposure			**Const.. Number**	**Panel Faces**	**HTM**		**Area or Length**	**Btuh**			**Area or Length**	**Btuh**			
					Htg.	**Clg.**		**Heating**	**S-Clg.**	**L-Clg.**		**Heating**	**S-Clg.**	**L-Clg.**	
6a	**Windows and Glass Doors**	a	Unit A = 1G	N	37.24	11.09	43.75	1,629	485						
		b	Unit A = 1G	E / W	37.24	37.10	43.75	1,629	1,623						
		c	Unit B = 1G	N	33.44	11.16	14.00	468	156						
		d	Unit B = 1G	S	33.44	15.81	28.00	936	443						
		e	Unit C = 1G	W	41.04	39.63	58.00	2,380	2,299						
		f	Unit D = 1G	S	41.04	17.30	47.13	1,934	815						
		g	Unit E = 1G	N	31.92	12.58	10.31	329	130						
		h	Unit E = 1G	S	31.92	22.88	10.31	329	236						
		i	(7)												
		j													
6b	**Skylights**	a	Unit 1 = 8G	N	98.42	100.75	8.00	787	806						
		b	Unit 2 = 8G	S	68.97	92.94	32.00	2,207	2,974						
		c													
7	**Wood and Metal Doors**	a	11N		26.60	9.1	21.0	559	191						
		b	11N		26.60	9.1	21.0	559	191						
		c													
8	**Above Grade Walls and Partitions**	a	14A-8		6.92	1.16	1,207	8,347	1,395						
		b	15A-4sffc wall		10.41	2.10	600	6,246	1,257						
		c	15A-4sffc part		0.90	0.18	96	87	17						
		d													
		e													
		f													
		g													
9	**Below Grade Walls**	a	15A-4sffc-4		6.00		284	1,705							
		b	15A-4ffc-8		4.71		224	1,055							
		c													
10	**Ceilings**	a	16B-30ad		2.43	1.60	1,752	4,261	2,803						
		b													
		c													
11	**Floors**	a	19B-osp		2.43	0.48	736	1,788	352						
		b	22B-5ph		44.76		64	2,865							
		c	21A-32		1.52		544	827							
		d													
12	**Infiltration**	**Heating Load (Btuh)**			Effect ACH	0.408	**WAR** 1.00	11,237			**WAR**				
		Sensible Load (Btuh)				0.194			1,054						
		Latent Load (Btuh)								1,651					
13	**Internal**	a	**Occupants at 230 and 200 Btuh**				(10) 4		920	800					
		b	**Scenario Number**	1					2,400						
		c	**Default Adjustments**	None											
		d	**Custom Appliances**	NA											
		e	**Plants**	None											
14	**Subtotals**	Sum lines 5 through 12						52,164	20,548	2,451					
15	**Duct Loads**	**EHLF & ESGF**			0.049	0.026		2,561	530						
		ELG								565					
16	**Ventilation Loads**	Vent Cfm	70	E Cfm	70			1,987	459	1,755					
17	**Winter Humidification Load**	**Gal / Day**	7.1					2,614							
18	**Piping Load**														
19	**Blower Heat**								1,707						
20	**AED Excursion & Latent Moisture Migration Load**							(14)	(15)	(16)					
21	**Total Load**	Sum Lines 13 Through 19						59,326	23,807	4,771					

Figure 2: J1 Worksheets A and Form J1

Part II: Manual S – Equipment Expanded Performance Data

XYZ Furnace Company

MODEL	060 - 14	080 - 14	080 - 16
TYPE	Downflow / Horizontal	Downflow / Horizontal	Downflow / Horizontal
RATINGS			
Input BTUH	60,000	80,000	80,000
Capacity BTUH (ICS)	48,000	64,000	64,000
AFUE	80.0	80.0	80.0
Temp. rise (Min.-Max.) °F.	30 - 60	35 - 65	35 - 65

Figure 3: Furnace Performance Data

Based on the heating output and temperature rise (TR) limitations the airflow should be about 1,185 CFM, based on:
CFM = 64,000 ÷ (50°F × 1.1 × 1.0) = 1,185 CFM

CFM = Btu ÷ (TR × 1.1 × ACF) where:

CFM: Cubic Feet per Minute, the volume of air moving through the equipment Btu/h: The heating capacity of the furnace or other heat source. The XYZ 80-14 has an output capacity of 64,000 Btu.

1.08: A physics constant that converts pounds of air to a volume of air.

ACF: Altitude Correction Factor, for homes at elevations above 1,000 feet. Ames Iowa elevation is 955 ft. therefore, the AC is 1.0.

For the air conditioner, below, the outdoor design temperature for this example is 90°F, this designer interpolated the value between the 85°F and the 95°F cooling performance values. In these situations, one could verify the math, or "eyeball" the listed capacity and ensure it falls within the other two capacities listed. Verifying the math may be of value however, the important element to verify is that the cooling equipment does not exceed the capacity limitations.

The Latent capacity was determined by subtracting the Sensible capacity from the Total capacity (29,300 – 21,400 = 7,900).

Note the air flow required to deliver the capacities stated (1,000 CFM).

XYZ Performance Data

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

OD Dry Bulb (F)	Indoor Entering Wet Bulb (F)	Total Capacity	Sensible Capacity at Entering Dry Bulb Temperature (F)			
			72	75	78	80
85	59	28,400	22,600	25,300	27,800	29,400
	63	29,900	18,800	21,600		
	67	32,100	15,100	17,900		
	71	34,700	11,400	14,200		
95	59	27,300	22,200	24,900		
	63	28,700	18,500	21,200		
	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.

Elements 25 and 26 are interpolated from the circled equipment capacity values.

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.			

Figure 4: Air Conditioner's Expanded Performance Data

Part III: Manual D Duct Sizing

The XYZ FR 08-14 blower assembly can deliver approximately 1,117 CFM on Med-Lo fan speed and 1,000 CFM on Low fan speed. 1,117 CFM is an acceptable amount of airflow for the furnace (this equates to a 53°F TR), and 1,000 CFM is the volume of air necessary for the cooling system. For more explanation, see the discussion about "Adjusting Design Airflow" (page 7) in "Understanding and Using the HVAC System Design Review Form."

XYZ Furnace Company Blower Data									
Air Delivery – CFM (with filter)									
Unit Size	Return Air Entry	Fan Speed	External Static Pressure (inches water column)						0.75
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
FR 060-14	1 side or bottom	High	1100	1065	1005	945	900	805	730	610
		Med-Low	890	865	810	765	705	620	540	475
		Low	745	710	670	625	565	505	425	360
FR 080-14	1 side or bottom	High	1740	1705	1660	1615	1570	1500	1425	1355
		Med-High	1500	1470	1445	1410	1375	1330	1280	1210
		Med-Low	1340	1315	1300	1270	1235	1200	1140	1095
		Low	1195	1175	1165	1130	1100	1070	1030	975
FR 080-16	1 side or bottom	High	2250	2175	2090	2020	1930	1855	1760	1670
		Med-High	2020	1950	1900	1840	1790	1710	1640	1545
		Med-Low	1725	1690	1660	1630	1575	1520	1460	1370
		Low	1490	1480	1460	1440	1380	1340	1295	1230
‡ • Airflow shown is for bottom only return-air supply with factory supplied 1-in. washable filter (0.05 IWC).										

Figure 5: Blower Performance Data

Friction Rate Worksheet

Step 1) Manufacturer's Blower Data (30) (29)

External static pressure (ESP) = 0.75 IWC Cfm = 1,185

Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	0.18
Electric resistance heating coil	
Hot water coil	
Heat exchanger	
Low efficiency filter	
High or mid-efficiency filter	0.13
Electronic filter	
Humidifier	
Supply outlet	0.03
Return grille	0.03
Balancing damper	0.03
UV lights or other device	

Total component losses (CPL) (31) 0.40 IWC

Step 3) Available Static Pressure (ASP) (32)

ASP = (ESP - CPL) = (0.75 - 0.40) = 0.35 IWC

Step 4) Total Effective Length (TEL) (33) (34) (35)

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

Step 5) Friction Rate Design Value (FR) (36)

FR value from friction rate chart = 0.09 IWC/100

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

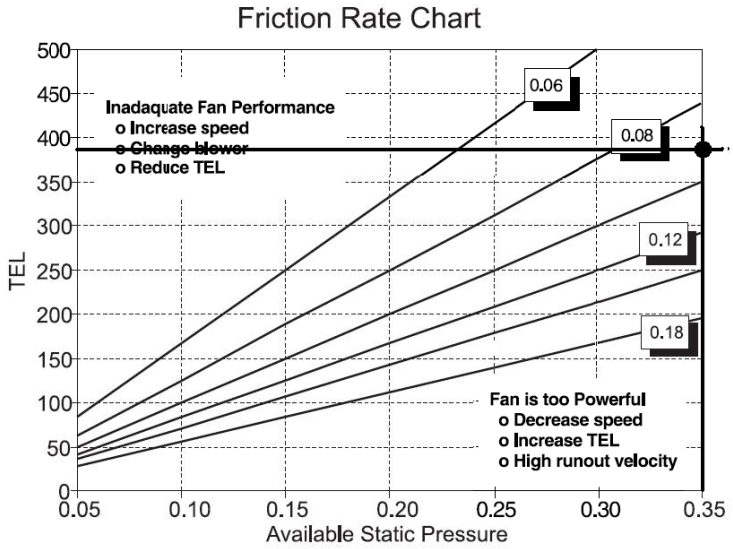
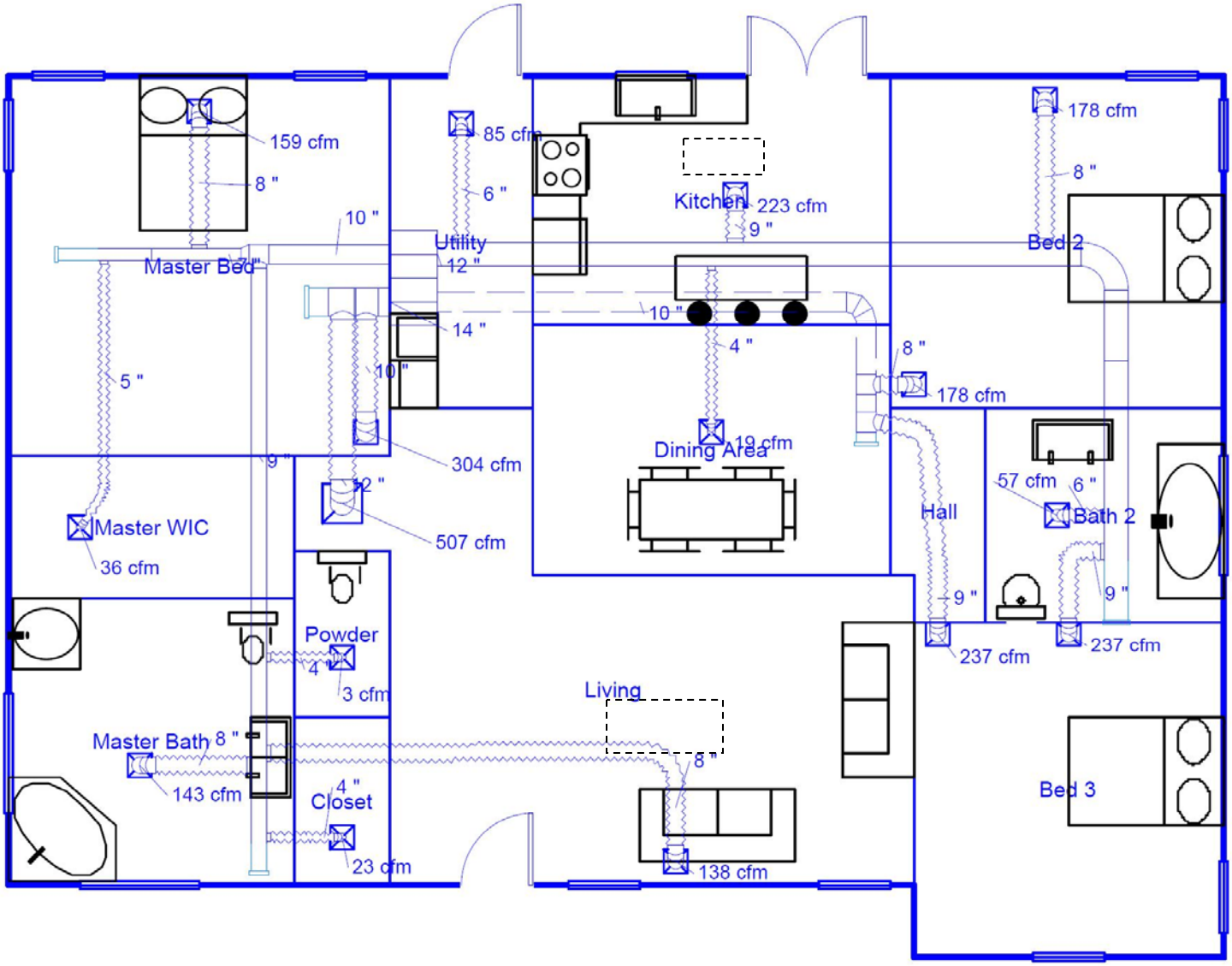


Figure 6: Example Friction Rate Worksheet

Duct Sketch


159 cfm
8 "
Master Bed
10 "
5 "
85 cfm
6 "
Utility
12 "
14 "
10 "
304 cfm
12 "
507 cfm
9 "
Master WIC
36 cfm
Powder
4 "
3 cfm
Master Bath
8 "
143 cfm
4 "
Closet
23 cfm
Kitchen
223 cfm
9 "
10 "
4 "
19 cfm
Dining Area
Living
8 "
138 cfm
178 cfm
8 "
Bed 2
8 "
178 cfm
Hall
9 "
237 cfm
57 cfm
6 "
Bath 2
9 "
237 cfm
Bed 3