Manual S

Breakdown Series for

Manual J, S, & D

Building Codes Support Program

Manual S is the second step in the residential HVAC design process. The designer is responsible for following the procedures for selection and sizing residential heating and cooling appliances as there are no approved manual S software systems available.

Submittal documents must include the performance data for all proposed heating and cooling appliances. This includes the expanded performance data for the air conditioner.

Explanations for the Wrightsoft "Project Summary" report

H. **Heating Equipment Summary**

Make Carrier:	Manufacturer
Trade Carrier:	Trade if different from the manufacturer
Model 58MCB040-12x:	Model number
AHRI ref 144278:	Has been tested, listed, and will provide the stated capacities. All units should have an AHRI number
Efficiency 92.1:	The efficiency of the proposed unit
Heating input 40,000 Btuh:	The heating capacity prior to deration for efficiency and altitude

Heating output 33,156 Btuh: The heating capacity after deration for efficiency and altitude. The manual J software will **not** derate for altitude this is something left to the designer. All the software knows how to do is derate for the efficiency. The manufacturers performance data will include the percentage used to derate for altitude. Gas fired appliances installed at elevations greater than 2,500 feet above sea level must be derated. The maximum allowed oversizing for a gas fired furnace is 40 percent. In this design the 40,000 BTU furnace has the needed capacity and is not oversized. However, if this furnace did not have the needed capacity, the next largest furnace would be acceptable even though it might be more than 40% oversized. As it is the smallest unit this manufacturer has that has the needed capacity.

Temperature rise 44° F: The software will calculate the temperature rise. This is a calculation of the output capacity and the heat CFM. The heat rise range will be part of the manufacturers performance data.

Actual air flow 830 cfm: Air flow for heating. The designer will choose the proper speed from the manufacturers performance data for the required airflow based on the temperature rise. The higher the CFM the lower the temperature rise. The lower the CFM the higher the temperature rise.

Air flow factor 0.031 cfm/Btuh: The software will calculate this factor. Based on actual airflow (cfm) and needed heating Btu's for each room.

<u>Static pressure 0.70 in H2O:</u> Total external pressure used by the designer. Please refer to the duct design technical paper for more information.

<u>Space thermostat:</u> The designer can add some specifications for a space thermostat. This design did not include one.

I. **Cooling Equipment Summary**

<u>Make Carrier</u>: The manufacturer

<u>Trade BASE 13 PURON AC</u>: The system's refrigerant

<u>Cond 24ABB324(A,W)31:</u> The systems outside unit model number

<u>Coil CAP**2414A**++TDR:</u> The indoor coil model number

<u>AHRI ref 3250356:</u> The listing number that verifies the indoor and outdoor units are compatible.

<u>Efficiency 11 EER, 13 SEER:</u> The system's efficiency

<u>Sensible cooling 18835 Btuh</u>: The sensible cooling capacity of the proposed unit from the manufacturers expanded performance data

<u>Latent cooling 2765 Btuh</u>: The latent cooling capacity of the proposed unit from the manufacturers expanded performance data

<u>Total cooling 21600 Btuh:</u> The total cooling capacity of the proposed unit

Xcel Energy®

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Actual air flow 995 cfm: Airflow from the manufacturer's performance data

Air flow factor 0.067 cfm/Btuh: Airflow factor is calculated by the software based on the CFM and the cooling load per room.

Static pressure in 0.70 H2O: Total external pressure used by the designer. Please refer to the duct design technical paper for more information.

Load sensible heat ratio 1.0: As discussed on the Manual J technical paper this is where the software calculates the actual sensible heat ratio.

Selection of air conditioning equipment in Colorado is more complicated than in other areas of the country. First there is no calculated latent load and second is the altitude.
Below is the expanded performance data for the air conditioning equipment selected for this project. Keep in mind all the performance data we will look at are the capacities at sea level.

The calculated cooling load for our example is 15,756 Btuh.

We will be using the 800 CFM row at a 63 degree entering wet bulb. (EWB)

The 95 degree column as this is within 5 degrees of our outside summer design dry bulb.

Total capacity is 21,600 Btuh with 16,080 Btuh of that being the sensible capacity.

Total capacity of 21,600 less the Sensible capacity of 16,080 = 5,520 Latent capacity

Per Manual S one half of the excess latent capacity can be converted to sensible capacity as this is self-correcting.

5,520/2= 2,760   16,080 + 2,760 = 18,840 new sensible capacity

Per Manual S we can be up to 15% oversized:

Target total load of 15,832 x 1.15 = 18,206 Btuh < 21,600 Btuh

So, we are technically slightly oversized, however the next smaller unit does not have the capacity to meet the load. In this case this air conditioner is acceptable.

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DETAILED COOLING CAPACITIES# CONTINUED

EVAPORATOR AIR		CONDENSER ENTERING AIF								
		75 (23.9)			85 (29.4)			95 (35)		
CFM	EWB °F (°C)	Capacity MBtuh		Total System KW**	Capacity MBtuh		Total System KW**	Capacity MBtuh		Total System KW**
		Total	Sens‡		Total	Sens‡		Total	Sens‡	
								24ABB324(A,W)31 Outdoor Section With CAP**241		
700	72 (22.2)	27.09	13.27	1.65	25.82	12.82	1.85	24.63	12.41	2.06
	67 (19.4)	24.89	16.41	1.65	23.83	15.99	1.84	22.71	15.56	2.05
	63 (17.2)††	23.39	15.98	1.64	22.38	15.55	1.84	21.29	15.11	2.05
	62 (16.7)	23.01	19.56	1.64	22.03	19.14	1.84	20.99	18.67	2.05
	57 (13.9)	22.46	22.46	1.64	21.66	21.66	1.83	20.79	20.79	2.05
800	72 (22.2)	27.52	13.92	1.69	26.15	13.46	1.88	24.91	13.04	2.10
	67 (19.4)	25.25	17.44	1.68	24.16	17.03	1.88	23.00	16.60	2.09
	63 (17.2)††	23.76	16.95	1.68	22.72	16.53	1.87	21.60	16.08	2.09
	62 (16.7)	23.47	20.99	1.68	22.49	20.52	1.87	21.52	21.52	2.09
	57 (13.9)	23.30	23.30	1.68	22.44	22.44	1.87	21.53	21.53	2.09

Now what about the effects of altitude. Unfortunately, very few if any manufacturers provide guidance for altitude adjustment for air conditioners. Fortunately, Manual S does provide two options.

One option is to derate the capacity based on your location above sea level. Please refer to appendix 5 of the Manual S 2nd edition that provides the tables and calculation necessary for deration.

The other is to increase the CFM to maintain sea level capacity and can be found in appendix 6 manual S first edition. Air is less dense at altitude than it is at sea level, so we need to move more air to maintain the same capacity. Many designers use this method.

The formula for air density correction: CFM at Altitude = Sea-Level Flow Rate / Density Ratio

Altitude Correction factors: 5000’= 0.832, 6000’ = 0.801, 7000’ = 0.772, 8000’ = 0.743

800 cfm/ 0.832 = 962 cfm. In our example we would need to move a minimum of 962 CFM to maintain same capacity of our air conditioner at 5000’ above sea level.

Our example used the smallest furnace by the manufacturer. There are times where the furnace size is correct for the capacity however the blower is too small to properly operate the air conditioner. In those cases, it is acceptable to upsize the furnace for a larger blower. The energy penalty for a larger gas fired furnace is not nearly as great as it is for an air conditioner that does not perform properly.

Project Summary
Entire House
ACME Design

Job: 1006
Date:
By:

Project Information

For: New House, Good Builder

Notes:

Design Information

A Weather: Denver, CO, US

B Winter Design Conditions

Outside db	-3	°F
Inside db	70	°F
Design TD	73	°F

C Summer Design Conditions

Outside db	***90***	°F
Inside db	75	°F
Design TD	15	°F
Daily range	H	
Relative humidity	50	%
Moisture difference	-36	gr/lb

D Heating Summary

Structure	26468	Btuh
Ducts	0	Btuh
Central vent (64 cfm)	4213	Btuh
Outside air		
Humidification	0	Btuh
Piping	0	Btuh
Equipment load	30680	Btuh

E Sensible Cooling Equipment Load Sizing

Structure	14878	Btuh
Ducts	0	Btuh
Central vent (64 cfm)	877	Btuh
Outside air		
Blower	0	Btuh
Use manufacturer's data	y	
Rate/swing multiplier	1.00	
Equipment sensible load	15756	Btuh

G Infiltration

Method		Simplified
Construction quality		Average
Fireplaces		0
	Heating	**Cooling**
Area (ft²)	3600	3600
Volume (ft³)	14464	14464
Air changes/hour	0.28	0.15
Equiv. AVF (cfm)	67	36

F Latent Cooling Equipment Load Sizing

Structure	274	Btuh
Ducts	0	Btuh
Central vent (64 cfm)	-1281	Btuh
Outside air		
Equipment latent load	0	Btuh
Equipment Total Load (Sen+Lat)	15756	Btuh
Req. total capacity at 0.85 SHR	1.5	ton

H Heating Equipment Summary

Make	Carrier	
Trade	Carrier	
Model	58MCB040-12x	
AHRI ref	144278	
Efficiency	92.1 AFUE	
Heating input	40000	Btuh
Heating output	33156	Btuh
Temperature rise	44	°F
Actual air flow	830	cfm
Air flow factor	0.031	cfm/Btuh
Static pressure	0.70	in H2O
Space thermostat		

I Cooling Equipment Summary

Make	Carrier	
Trade	BASE 13 PURON AC	
Cond	24ABB324(A,W)31	
Coil	CAP**2414A**++TDR	
AHRI ref	3250356	
Efficiency	11.0 EER, 13 SEER	
Sensible cooling	18835	Btuh
Latent cooling	2765	Btuh
Total cooling	21600	Btuh
Actual air flow	995	cfm
Air flow factor	0.067	cfm/Btuh
Static pressure	0.70	in H2O
Load sensible heat ratio	1.00	

Bold/italic values have been manually overridden

Calculations approved by ACCA to meet all requirements of Manual J 8th Ed.