Heat Pump Performance Verification

PROGRAM

Nebraska Public Power District and our Wholesale Partners are excited to bring you a new heat pump performance verification program. This booklet will walk you through the steps necessary to conduct a system performance verification as well as complete the application form.

Key process steps include:

1) Determine System CFM (pages 2-4)
2) Heat Pump Capacity – Heating Mode (pages 5-6) OR
   Heat Pump Capacity – Cooling Mode (pages 7-9)
3) Complete The Form (last two pages)

NOTE: Example Scenario Data – Page 10

Recommended tools:

- Air pressure measurement devise (i.e. magnehelic, digital manometer, incline manometer, etc.)
- Temperature probe
- Equipment specifications

Additional forms and information is located at www.nppd.com (go to “My Home”, and then under the “Residential “ heading, click on “HP Performance Verification Program”). If you have additional questions please contact: Roger Hunt at 402-239-9406; John Koperski at 308-289-0463; Chad Podolak at 402-563-5482 or Kelly Beiermann at 402-563-5415.

Nebraska Public Power District

“Always there when you need us”

Option #1

CFM CALCULATION

Using Total External Static Pressure
(* Enter Results On Application Form - Section #4A)

Return Air Static (after filter) _____

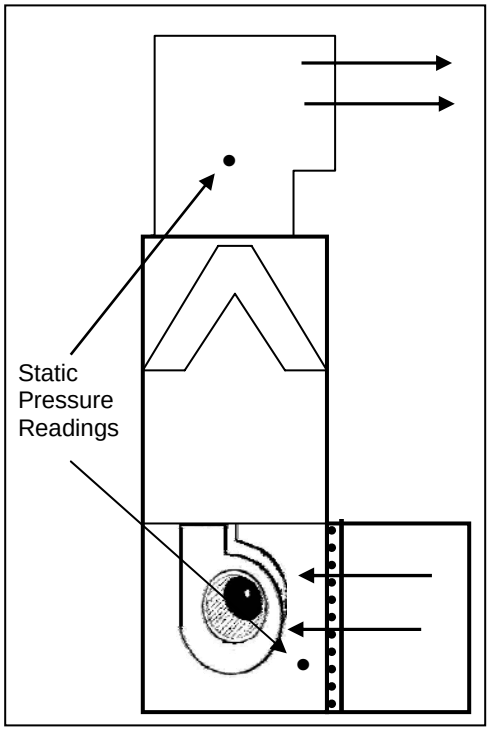
Supply Air Static (at plenum) _____

Coil Static (from manufacturer) _____
(need to include evaporator coil's static pressure if the coil is located between the fan and the supply air static reading - see page 3 for an example chart)

Total External Static Pressure* *(Form - #4A)* _____

CFM* *(Form - #4A)* _____
(per Mfg. Specifications from the total external static pressure – see chart on bottom of page 3)

NOTE: Total External Static Pressure can determine CFM for any furnace. It is the summation of everything external to the furnace cabinet (i.e. return duct, supply duct, and likely the indoor coil). For electric furnaces, there is another option to the total external static pressure and that is discussed on page 4 and is listed as option #2.



COIL STATIC PRESSURE DROP

(IN. W.C.)

UNIT SIZE	BULB	AIR QUANTITY (CFM)				
		900	1000	1100	1200	1300
A036	WET	0.16	0.20	0.24	0.28	0.33
	DRY	0.14	0.17	0.21	0.24	0.28

- May have to include a “correction factor” if return air temperature is less than 75°F or more than 85°F.
- Other equipment specification that may apply.

AIR DELIVERY – CFM

(with filter)

SIZE	SPEED	EXTERNAL STAIC PRESSURE (In. wc)									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
36070	High	1440	1400	1355	1300	1240	1170	1090	1000	890	745
	Mid-High	1180	1165	1150	1125	1085	1030	970	890	785	645
	Medium	1015	1020	1010	990	965	925	875	800	700	560
	Med-Low	885	885	880	865	845	815	770	700	605	475
	Low	695	700	700	690	670	640	600	540	460	345

- If the return static pressure reading is taking before (upstream) of the filter, a static pressure value has to be included for the static pressure of the filter.
- Other equipment specification that may apply.

Option #2

CFM CALCULATION

Measuring Electric Furnace – Energy Consumption Method
(* Enter Results On Application Form - Section #4B)

First, it's important in this option to determine the performance of just the furnace. Therefore, turn the thermostat to the "emergency heat" mode. Then, with the outdoor heat pump off, measure the voltage and the total amperage of the strip heat and indoor fan. Next calculate the BTUH: BTUH = Amps x Volts x 3.413

Example: An electric furnace operating at 240 volts is drawing 41 amps. Entering air is 65° D.B. and leaving air is 98° D.B. Find the airflow rate in CFM.

Airflow Check * – temperature rise method with electric furnace (test in emergency heat mode):

a) _____Volts x _____Amps = _____ Watts

b) _____Watts x 3.414 = _____ BTUH

c) _____ Supply Air °F. (minus) _____ Return Air °F. = _____ Temp. Difference (TD) °F.

d) _____ BTUH (divided by) 1.08 (divided by) _____ (TD) °F. = _____ CFM

NOTE: CFM Formula:

$$CFM = \frac{BTUH}{1.08 \times TD}$$

HEATING MODE

Heat Pump Capacity Verification

(* Enter Results On Application Form - Section #5A & 6)

1) Measured Capacity* ***(Form - #5A)***

BTUH = CFM x TD x 1.08

_____ = _____ x _____ x 1.08

NOTE: Make sure the TD is obtained when the heat pump is running **WITHOUT** any strip heat or backup heat on!

2) Manufacturer's Rated Capacity* ***(Form - #6)***

_____ Current Outdoor Air Temperature (OAT) – at Outdoor Coil

_____ BTUH – Manufacturer's Rated Capacity for Above OAT (see page 6)

3) % Difference* ***(Form - #6)***

Rated Capacity (-) Measured Capacity (÷) Rated Capacity (=) % Difference

↓ ↓ ↓ ↓

_____ (-)_____ (÷)_____ = _____ % Difference

% Difference must be within 10% to be in compliance.

HEAT PUMP
HEATING PERFORMANCE

(Example)

INDOOR AIR		OUTDOOR COIL ENTERING AIR TEMPERATURES °F																							
		–3			7			17			27			37			47			57			67		
		Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr	Capacity MBtuh†		Total Pwr
EDB	CFM	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†	Total	Int*	kW†
650A030-D, E Outdoor Section With FX4(A,B)NF030 Indoor Section																									
65	825	12.2	11.2	2.05	15.2	14.0	2.11	18.3	16.7	2.17	21.7	19.2	2.23	25.5	23.2	2.30	29.7	29.7	2.40	34.5	34.5	2.51	40.1	40.1	2.68
	1050	12.6	11.6	2.09	15.7	14.4	2.13	18.7	17.1	2.17	22.1	19.7	2.22	26.0	23.7	2.28	30.4	30.4	2.35	35.4	35.4	2.46	41.2	41.2	2.60
	1250	12.9	11.9	2.13	16.0	14.7	2.16	19.1	17.4	2.20	22.5	20.0	2.23	26.5	24.1	2.28	30.9	30.9	2.35	36.0	36.0	2.44	41.6	41.6	2.54
70	825	11.8	10.9	2.15	14.9	13.7	2.21	18.1	16.5	2.28	21.4	19.0	2.34	25.1	22.8	2.42	29.3	29.3	2.52	34.1	34.1	2.64	39.5	39.5	2.81
	1050	12.2	11.2	2.18	15.3	14.1	2.23	18.5	16.9	2.28	21.8	19.4	2.33	25.7	23.3	2.39	30.0	30.0	2.47	34.8	34.8	2.57	40.5	40.5	2.72
	1250	12.5	11.5	2.23	15.7	14.4	2.26	18.8	17.2	2.30	22.2	19.7	2.34	26.1	23.7	2.39	30.5	30.5	2.46	35.4	35.4	2.55	41.3	41.3	2.69
75	825	11.4	10.5	2.24	14.5	13.3	2.31	17.8	16.2	2.39	21.1	18.7	2.46	24.8	22.5	2.54	28.9	28.9	2.64	33.6	33.6	2.77	38.8	38.8	2.94
	1050	11.8	10.8	2.28	14.9	13.7	2.33	18.2	16.6	2.39	21.6	19.1	2.44	25.3	23.0	2.51	29.6	29.6	2.59	34.4	34.4	2.70	39.9	39.9	2.85
	1250	12.1	11.1	2.32	15.3	14.1	2.36	18.6	16.9	2.41	21.9	19.5	2.45	25.7	23.4	2.51	30.1	30.1	2.58	35.0	35.0	2.67	40.6	40.6	2.81

COOLING MODE

Heat Pump Capacity Verification

TOTAL HEAT (ENTHALPY) IS

THE SUM OF SENSIBLE HEAT AND LATENT HEAT

The total heat content of air is call enthalpy. It is measured in BTU per pound of standard dry air, and is abbreviated as “H” in formulas and equations. Sensible heat is the heat, which causes a change in temperature of substance. Latent heat is the heat, which causes a change of state without any changes of temperature.

TOTAL HEAT EQUATION IS:

BTUH = CFM X HD X 4.5

Total heat change, as determined from wet bulb temperatures is the only means of checking total cooling capacity in the field. Dry bulb temperature drop, over a coil, tells only the sensible cooling performance.

COOLING MODE

Heat Pump Capacity Verification

(* Enter Results On Application Form - Section #5B & 6)

1) Measured Capacity* (Form - #5B)

_____ Enthalpy (H) Wet Bulb Temperature of Return Air (back of Form)

_____ Enthalpy (H) Wet Bulb Temperature of Supply Air (back of Form)

_____ Enthalpy Difference (HD)

4.5 x _____ CFM x _____ Enthalpy Difference = _____ BTUH

Make sure the unit runs in the cooling mode at least 10 minutes to saturate the evaporator coil.

2) Manufacturer's Rated Capacity* (Form - #6)

_____ Current Outdoor Air Temperature (OAT) – at Outdoor Coil

_____ BTUH – Manufacturer Rated Capacity For Above OAT (see page 9)

3) % Difference* (Form - #6)

Rated Capacity	(-)	Measured Capacity	(÷)	Rated Capacity	(=)	% Difference
↓		↓		↓		↓

_____ (-)_____ (÷)_____ = _____ % Difference

% Difference must be within 10% to be in compliance.

COOLING CAPACITY

(Example)

EVAP AIR		CONDENSER ENTERING AIR TEMPERATURES °F																	
		75			85			95			105			115			125		
		Capacity MBtuh†		Total Sys kW**	Capacity MBtuh†		Total Sys kW**	Capacity MBtuh†		Total Sys kW**	Capacity MBtuh†		Total Sys kW**	Capacity MBtuh†		Total Sys kW**	Capacity MBtuh†		Total Sys kW**
CFM	EWB	Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡	
650AN030-D, E Outdoor Section With FX4(A,B)NF030 Indoor Section																			
825	72	34.3	17.2	2.07	32.6	16.6	2.31	30.9	15.9	2.58	29.0	15.3	2.87	27.0	14.6	3.20	24.8	13.8	3.56
	67	31.4	21.7	2.06	29.9	21.1	2.29	28.3	20.5	2.56	26.6	19.8	2.86	24.8	19.1	3.18	22.7	18.3	3.54
	63††	29.2	21.1	2.04	27.8	20.5	2.28	26.4	19.9	2.55	24.8	19.2	2.84	23.1	18.5	3.17	21.2	17.7	3.53
	62	28.8	26.2	2.04	27.4	25.5	2.28	26.0	24.8	2.55	24.5	24.0	2.84	23.0	23.0	3.17	21.4	21.4	3.53
	57	27.8	27.8	2.04	26.7	26.7	2.27	25.6	25.6	2.54	24.3	24.3	2.84	23.0	23.0	3.17	21.4	21.4	3.53
1050	72	35.2	18.7	2.14	33.5	18.1	2.38	31.6	17.4	2.65	29.7	16.8	2.94	27.6	16.1	3.27	25.2	15.3	3.62
	67	32.4	24.3	2.13	30.7	23.7	2.36	29.0	23.0	2.63	27.2	22.3	2.93	25.3	21.6	3.25	23.2	20.7	3.61
	63††	30.2	23.6	2.11	28.6	22.9	2.35	27.0	22.3	2.62	25.4	21.5	2.91	23.6	20.8	3.24	21.6	19.9	3.59
	62	29.9	29.4	2.11	28.6	28.5	2.35	27.2	27.2	2.62	25.8	25.8	2.91	24.3	24.3	3.24	22.5	22.5	3.60
	57	29.8	29.8	2.11	28.5	28.5	2.35	27.2	27.2	2.62	25.8	25.8	2.91	24.3	24.3	3.24	22.6	22.6	3.60
1250	72	35.8	20.0	2.20	34.0	19.4	2.44	32.1	18.7	2.71	30.0	18.1	3.00	27.8	17.3	3.33	25.4	16.5	3.68
	67	32.9	26.5	2.19	31.2	25.8	2.42	29.4	25.1	2.69	27.6	24.4	2.98	25.6	23.6	3.31	23.4	22.6	3.67
	63††	30.7	25.6	2.17	29.1	24.9	2.41	27.5	24.2	2.67	25.7	23.4	2.97	23.9	22.6	3.30	21.9	21.5	3.65
	62	31.0	31.0	2.17	29.7	29.7	2.41	28.3	28.3	2.68	26.8	26.8	2.98	25.1	25.1	3.31	23.2	23.2	3.67
	57	31.0	31.0	2.17	29.7	29.7	2.41	28.3	28.3	2.68	26.8	26.8	2.98	25.1	25.1	3.31	23.2	23.2	3.67

Example Scenario Data

12 SEER Heat Pump
2.5 Ton Condensing Unit
10 KW Resistance Heat

For Total External Static Pressure Test:

- Return Air Static = .25
- Supply Air Static = .16
- Coil Static = .17
- Fan Speed = Medium

For Heat Pump Operation – Heating Mode:

- Return Dry Bulb = 65°F
- Supply Dry Bulb = 86°F
- Outdoor Air Temp. = 27°F

For Heat Pump Operation – Cooling Mode:

- Return Wet Bulb = 67°F
- Supply Wet Bulb = 58°F
- Outdoor Air Temp. = 95°F

Heat Pump Performance Verification - Program Guidelines

- The heat pump performance verification program is applicable for installations after January 1, 2005.
- Qualifying systems include any SEER heat pump installed in a residential application that is either a newly constructed house, or a conversion situation in which the existing central air conditioner is replaced with a new heat pump.
- Like heat pump system upgrades are not eligible (ex. existing air source heat pump replaced with a new air source heat pump).
- Dealers will be paid $150 for systems in compliance.
- If there are two heat pump systems conditioning the house, dealers will be paid $75 for the second heat pump system that also is in compliance.
- To participate, the heat pump installer will conduct a performance test on the system to ensure it is operating as intended. Typical performance information required includes: airflow in c.f.m., measured Btuh output, design Btuh output and outdoor air temperature. If the measured output is within 10% of design output (established by the manufacturer), then the system is assumed to be within compliance.
- The dealer completes an application form and sends it to the homeowner's electric utility. Typical information on the form includes; the performance data of the heat pump system, homeowner and dealer name, address, etc.
- This program is completely voluntary for dealers.
- The installer has a one-year period from when the equipment is installed to when the application form would still be accepted.
- HVAC dealers will receive one check a month for successful applications that are processed, regardless of the number of different participating electric utilities that are involved. Accompanying this check will be a report indicating the applications that have been processed, and information such as; homeowner's name, homeowner's electric utility, date, etc.
- Utilities may inform their customers' (the homeowner) that their system has passed the heat pump performance verification test, per the data submitted by their HVAC dealer.
- NPPD reserves the right to conduct random heat pump performance verification tests with the dealer to ensure accuracy.
- If it is determined that the information provided by the dealers is fraudulent, disciplinary actions will be taken.

Enthalpy Chart

Wet Bulb Temp.	Enthalpy	Wet Bulb Temp.	Enthalpy
40	15.23	60	26.46
41	15.70	61	27.15
42	16.17	62	27.85
43	16.66	63	28.57
44	17.15	64	29.31
45	17.65	65	30.06
46	18.16	66	30.83
47	18.68	67	31.62
48	19.21	68	32.42
49	19.75	69	33.25
50	20.30	70	34.09
51	20.86	71	34.95
52	21.44	72	35.83
53	22.02	73	36.74
54	22.62	74	37.66
55	23.22	75	38.61
56	23.84	76	39.57
57	24.48	77	40.57
58	25.12	78	41.58
59	25.78	79	42.62

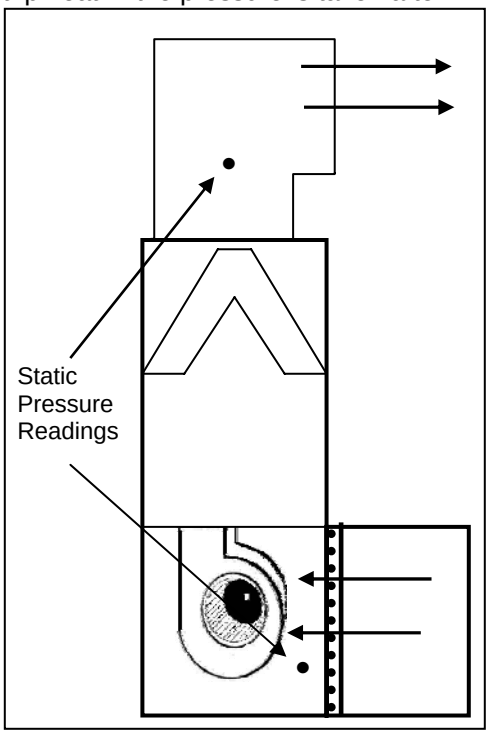
Footnotes for the following front-side sections:

Miscellaneous

- An average of multiple temperature readings taken over a cross-section of the duct will provide the most accurate temperature.
- When determining CFM with ECM motors, identify the CFM that the motor is programmed for.

Section 4A) Static pressure

- One method of determining the external static pressure is to take 1) one reading before the fan, and 2) the other reading should be taken either before or after the indoor coil/strip heat. If the pressure is taken after the indoor coil/strip heat, static pressure values will have to be added to the total to compensate for these components. The values for these two components should be in the equipment specifications.
- Once the total external static pressure is determined, the equipment specifications for that furnace will indicate what the equivalent CFM is.



Section 4B) Airflow check

- Operate thermostat in emergency heat mode.
- Heat pump should not be operating to determine CFM.
- Make sure fan speed is at 100% (or the speed at which the fan operates if the heat pump would be on).
- Temperature readings—make sure the temperature probe and the resistance heaters are not in direct sight of each other.

Section 5A) When checking the heat pump capacity in the heating mode, make sure the auxiliary heat is switched off.

Section 5B) When checking capacity in the cooling mode, make sure the system runs at least 10 minutes to get a wet indoor coil.

Section 6) Manufacturer's rating HP capacity—this Btuh value is obtained from the equipment specifications integrated performance curve (indicates Btuh output for various outdoor air temperatures).

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46	18.16	66	30.83
47	18.68	67	31.62
48	19.21	68	32.42
49	19.75	69	33.25
50	20.30	70	34.09
51	20.86	71	34.95
52	21.44	72	35.83
53	22.02	73	36.74
54	22.62	74	37.66
55	23.22	75	38.61
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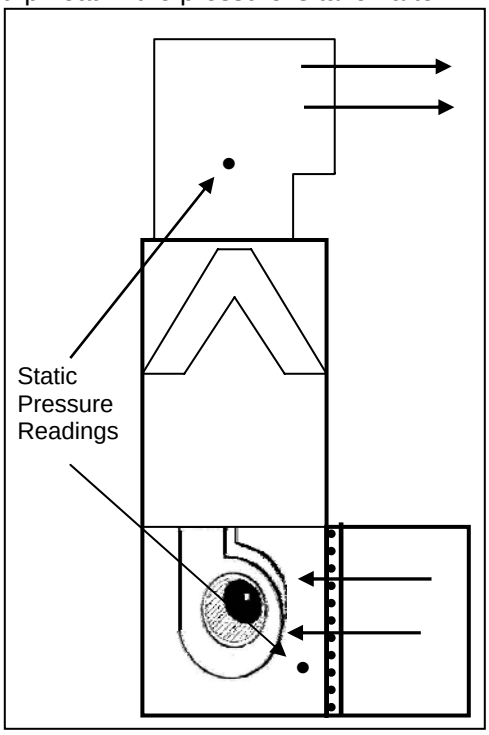

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