KEES, INC.

Products for Sheet Metal HVAC, Food Service, & Architectural Construction Industries

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BALANCING MANUAL

FORWARD:

A system not properly balanced will seldom be satisfactory and will eventually result in loss of time and future business. A balancing report prepared by the hood sales agency, the installing contractor, or a hired balancing service should be on record.

PROCEDURE: BALANCE EXHAUST

Start the exhaust fan only; verify that proper voltage is being applied, that the wheel is rotating in the proper direction, and that the hood filters are relatively clean. Be sure that if a fire damper or self-acting shutter is in the exhaust duct that it is in the open position. Take an amperage reading on the motor to be sure it is not overloaded and record along with name plate amperage. Take fan RPM with a tachometer. This is the RPM of the driven pulley. Record frame model of motor.

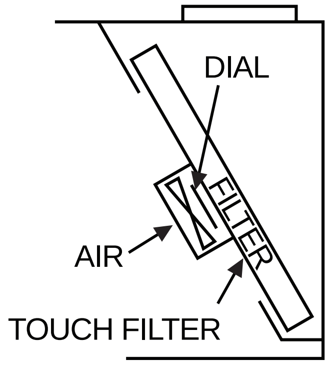
Note! Open door or windows to allow air to enter kitchen area while balancing exhaust. (Do **not** start supply fan.)

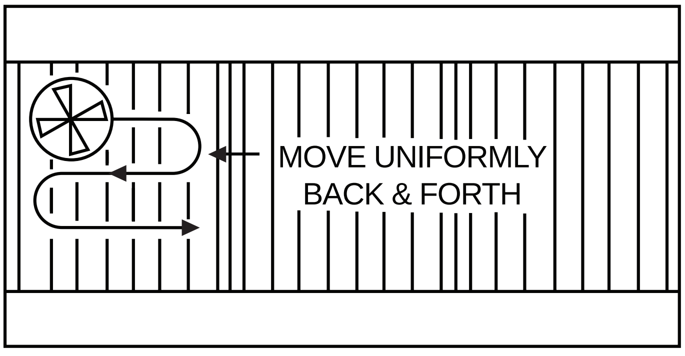
A. ANEMOMETER (Rotating Vane)

1. Verify that wheel is rotating freely and that correction table is available as this unit does not read accurately in all velocity ranges.

2. Place dial side of meter touching filter as a anemometer is calibrated to read air entering side opposite dial and will move dial in a clockwise rotation.

3. Time your readings with a watch for 1 minute, or use 30 seconds and multiply your readings by 2, to get feet per minute air velocity. Uniformly traverse the entire area of each filter excluding the filter frame. Use your correction table to get the true average velocity for each filter. The tables below give effective area for the Component Hardware Group Inc. baffle filters used in KEES hoods.



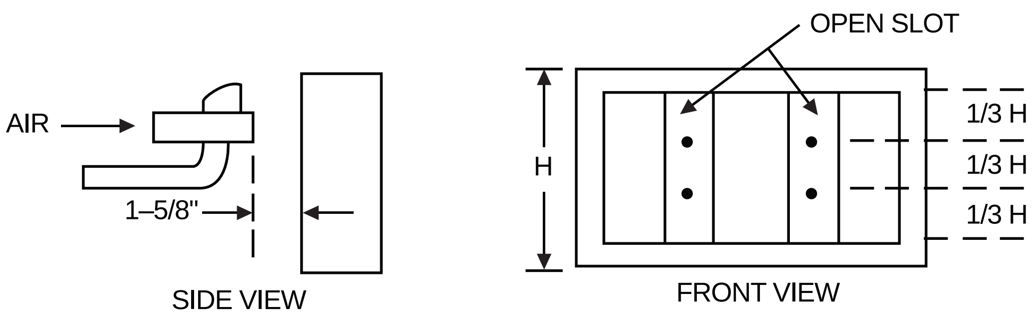


EFFECTIVE AREA The effective areas for the following nominal size filters are:	
10" x 20" x 2"	1.00 Square Feet
12" x 20" x 2"	1.25 Square Feet
16" x 20" x 2"	1.75 Square Feet
16" x 25" x 2"	2.24 Square Feet
20" x 20" x 2"	2.25 Square Feet
20" x 25" x 2"	2.88 Square Feet
25" x 25" x 2"	3.67 Square Feet

Adding up the CFM's for each filter gives the total exhaust. If the total air quantity measured is within plus (+) or minus (-) 5% of the design quantity, the exhaust system is balanced.

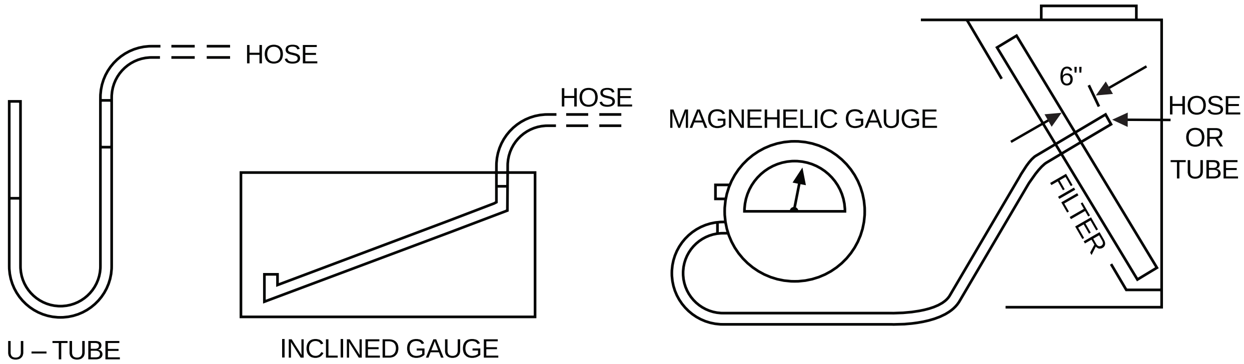
B. ALNOR VELOMETER

Use Jet Nos. 2225, 3930, or exhaust style No. 6070 which is attached to the negative (-) terminal. Set needle at zero using adjustment screw on face of unit. Hold jet 1-5/8" out from centerline of slotted exhaust opening and take at least 2 equally spaced readings per slot. Do this for each slot in the filter. Add up all the readings and divide by the number of readings to get average velocity. This figure times the effective area of the filter in sq. ft. gives air quantity in CFM for that filter. Adding the CFM for each filter gives the total exhaust. CFM (per filter) = Average velocity x effective area (sq. ft.).
Total exhaust = Sum of exhaust of each filter.



C. INCLINED GAUGE

Insert a thin tube through the filter slot until the tube end is approximately 6" behind center of filter. Connect tube to rubber hose and hose to suction side of magnehelic gauge, U tube of water, or high side of inclined gauge. Read pressure drop across filter. Repeat for each filter. Enter chart below for proper type and size filter and read CFM per filter. Add up CFM for each filter to get total exhaust.



FLOW RATE	CFM VS. STATIC PRESSURE STATIC PRESSURE FILTER SIZE							
CFM	**10 x 20**	**12 x 16**	**12 x 20**	**16 x 16**	**16 x 20**	**20 x 20**	**16 x 25**	**20 x 25**
200	0.13	0.15	0.10	0.07	0.04	0.04	0.04	0.03
250	0.20	0.23	0.16	0.12	0.07	0.06	0.07	0.04
300	0.29	0.33	0.23	0.17	0.09	0.08	0.09	0.06
400	0.52	0.59	0.40	0.30	0.17	0.15	0.17	0.11
450	0.66	0.75	0.51	0.38	0.21	0.19	0.21	0.14
500	0.81	0.93	0.63	0.46	0.26	0.23	0.26	0.18
550	0.98	1.12	0.76	0.56	0.32	0.28	0.32	0.21
600	1.17		0.90	0.67	0.38	0.33	0.38	0.25
650			1.06	0.79	0.45	0.39	0.44	0.30
700				0.91	0.52	0.45	0.51	0.35
750				1.05	0.59	0.52	0.59	0.40
800					0.68	0.59	0.67	0.45
850					0.76	0.67	0.75	0.51
900					0.85	0.75	0.85	0.57
950					0.95	0.83	0.94	0.64
1000					1.05	0.92	1.04	0.71

NOTE: 1. Recommended face velocity is 200 to 400 F.P.M.
2. The first number of size indicates vertical height, the second number represents horizontal width; both are nominal dimensions. Actual dimensions of filters are 7/16'' less than nominal. Actual thickness is 1-3/4''.

D. TO ADJUST AIR QUANTITY

Fundamentals of blower operation are as follows on a constant system such as an installed hood system:

1. CFM varies directly with RPM.

$$\frac{\text{CFM Required}}{\text{CFM Measured}} = \frac{\text{RPM Required}}{\text{RPM Measured}}$$

2. Static pressure varies as the square of RPM.

$$\frac{\text{Ps Required}}{\text{Ps Measured}} = \left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)^2$$

3. Amps (HP) varies as the cube of RPM.

$$\frac{\text{AMPs Required}}{\text{AMPs Measured}} = \left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)^3$$

If air quantity is low, first be sure amperage draw is not already at maximum before increasing diameter of motor pulley. From formula 1, determine new required RPM:

$$\text{RPM Required} = \text{RPM Measured} \times \frac{\text{CFM Required}}{\text{CFM Measured}}$$

Example: Air measured is 2000 CFM, but 2200 is required. Amps measured is 2.7 against a motor name plate reading of 3.6. Fan RPM is 640. Find required RPM and determine if existing motor is big enough.

$$\text{RPM Required} = \text{RPM Measured} \times \frac{\text{CFM Required}}{\text{CFM Measured}} = 640 \times \frac{2200}{2000} = 704$$

$$\text{Amps Required} = \text{Amps Measured}\left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)^3$$

$$= (\text{Amps Measured})\left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)\left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)\left(\frac{\text{RPM Required}}{\text{RPM Measured}}\right)$$

$$= (2.7)\left(\frac{704}{640}\right)\left(\frac{704}{640}\right)\left(\frac{704}{640}\right) = 2.7 \times 1.1 \times 1.1 \times 1.1$$

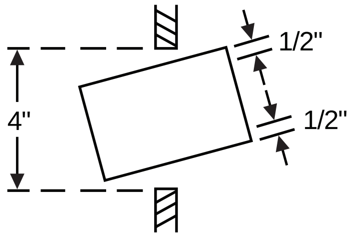
= 3.59 – – so motor is OK.

PROCEDURE: BALANCE SUPPLY ON ENERGY SAVER

Keep exhaust fan running, verify proper motor voltage, record RPM of supply fan driven pulley, record actual motor amperage, record full load amps shown on motor name plate, and record motor frame number.

E. ALNOR VELOMETER

Attach jet 2220, 2220-A, 3920 or 6070 to positive (+) side of meter. Take readings ½" down and ½" up from edge of KEES nozzle and in the plane of the nozzle discharge.

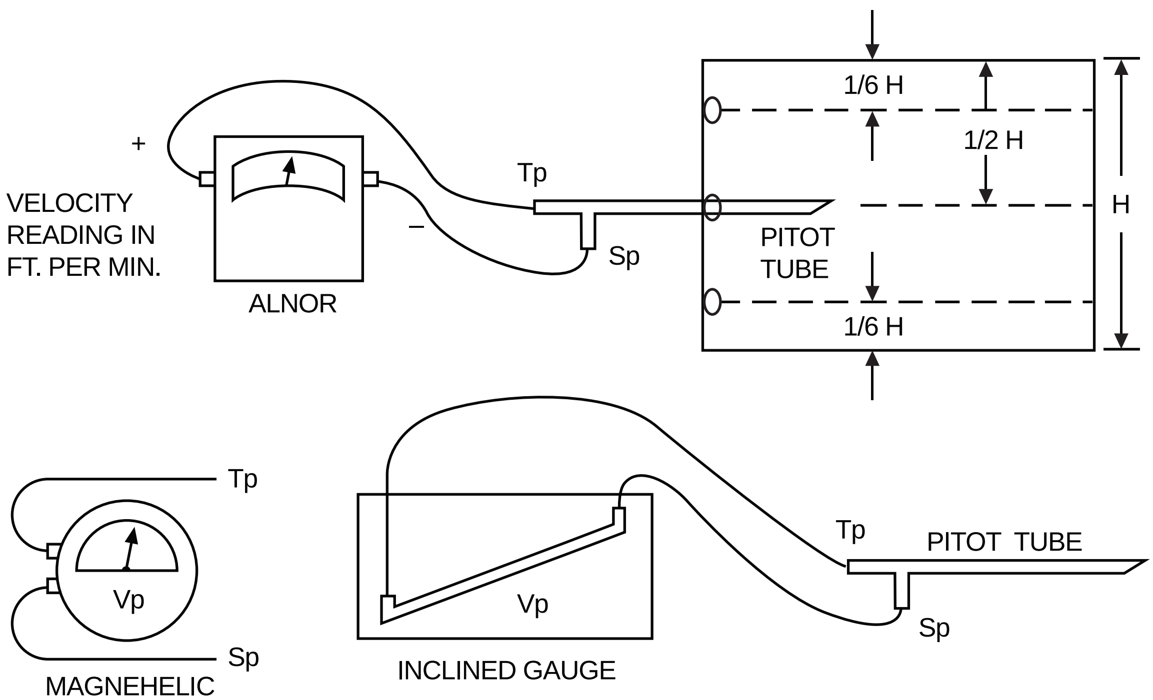


Readings should be taken at 1 foot intervals along each nozzle. Multiply average jet velocity times area of nozzle in sq. ft. to get CFM for that nozzle. Area of nozzle is its length in feet x 1/3. 1/3 represents a 4" wide opening in the supply plenum to which the nozzle is connected. Add together the CFM of all nozzles.

F. PITOT TUBE

1. **If used with Alnor,** connect total pressure opening to plus (+) side of gauge and static pressure opening to negative (-) side of gauge. Take readings at end of longest straight run of duct. Drill 3 equally spaced holes on the side of the supply duct. Take readings by inserting tube equal distances into duct and average readings. Area of duct in sq. ft. x average velocity reading gives CFM.

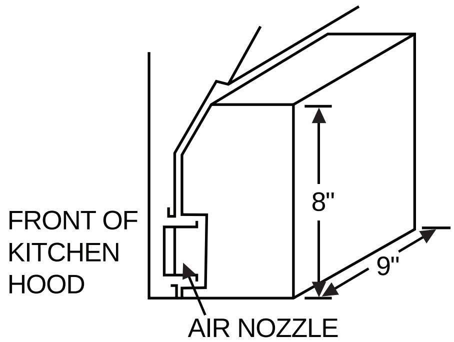
2. **If pitot tube is used with inclined gauge**, connect total pressure opening to low side of gauge and static pressure opening to high side of gauge. Resultant reading gives velocity pressure (Vp). Enter table below to get air velocity and multiply by duct area in sq. ft. to get CFM. A magnehelic gauge can be substituted for the inclined gauge.



VELOCITY PRESSURES FOR DIFFERENT VELOCITIES VELOCITY (V) IN FEET PER MINUTE AND VELOCITY PRESSURE (VP) IN INCHES OF WATER							
VP	V	VP	V	VP	V	VP	V
0.01	400	0.09	1201	0.17	1651	0.25	2003
0.02	566	0.10	1266	0.18	1699	0.26	2042
0.03	694	0.11	1328	0.19	1746	0.27	2081
0.04	801	0.12	1387	0.20	1791	0.28	2119
0.05	896	0.13	1444	0.21	1835	0.29	2157
0.06	981	0.14	1498	0.22	1879	0.30	2193
0.07	1060	0.15	1551	0.23	1921	0.31	2230
0.08	1133	0.16	1602	0.24	1962	0.32	2260

G. AIR GATHERING BOX

Devise a cardboard box to fit over nozzle as tightly as possible and terminate box in a rectangular opening. Take reading in the opening using anemometer or Alnor jet as previously described.



= 1/2 sq. ft.

H. TO ADJUST AIR QUANTITY

Follow procedures in D.

I. DUCT DESIGN

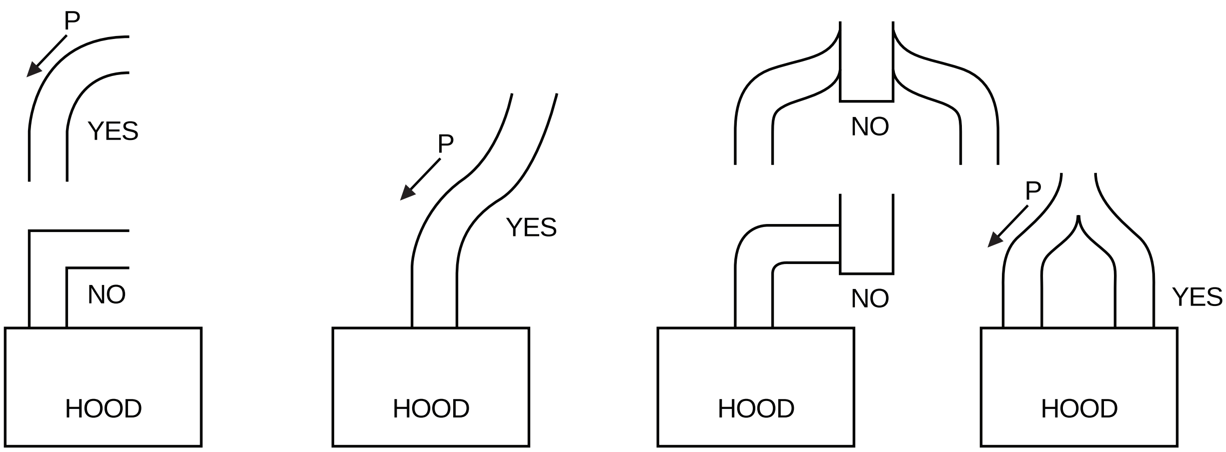
1. Exhaust Duct: Locate opening as close to center of hood as possible. Size for velocity of 1500 FPM or slightly higher rather than go to the maximum allowed.

Area in sq. ft. of duct = $\frac{CFM}{1500}$

Sq. in. of duct – sq. ft. x 144.

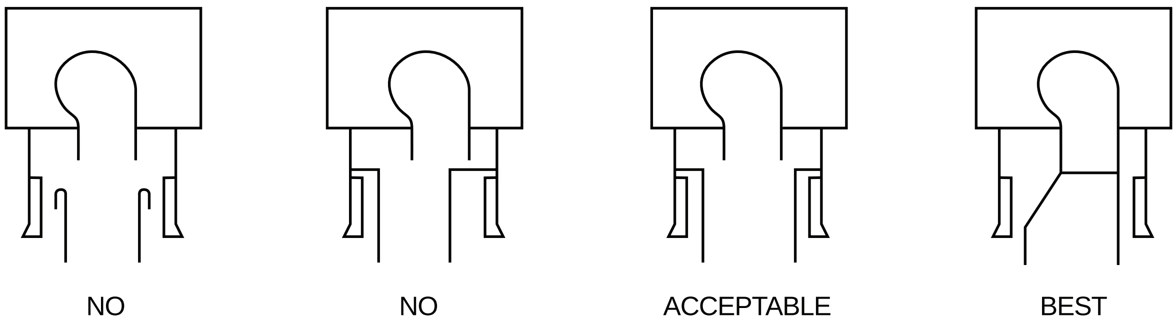
Avoid square elbows. Use long sweep elbows if possible.

Do not stub one duct into another at 90º. Enter one duct into another with a sweeping turn in direction of air flow – using a sweeping “pair of pants” when two ducts from a long hood join a vertical riser.



Pitch branch ducts back toward hood to prevent pockets of grease collecting in ductwork. On long horizontal ducts utilizing in-line centrifugal fans, provide access door in housing of fan and clean out doors in ductwork.

2. **Supply Duct for Energy Saver:** Locate opening into hood as close to center as possible. Size ductwork for 1200 FPM or less and avoid higher velocities if possible. Be sure to install perforated plate below supply opening. Avoid 90º elbows unless turning vanes are used. Avoid stubbing one duct into another without using an adjustable scoop. Long sweep elbows are preferred. See sketches – same as exhaust. Connect duct directly to fan outlet or discharge into duct which is larger than the blower outlet and which has been sealed off to the top of the curb. Under no circumstances can any part of the blower outlet be blanked off by curbing or ductwork. Do **not** stub supply duct into curb and have blower used inside of curb as a plenum. Install balancing and shut-off damper. Wrap outside of duct with insulation.



3. **Air Density:** On an energy saving hood, supply air will increase in temperature as it mixes with heat and steam from the cooking below but just how much depends on BTU input to cooking equipment, loss due to radiation, etc. The only sure way to know is to insert a thermostat in the plenum behind the filters or in the fan exhaust.

   Air increases in volume by approximately 2% for each 10º rise in temperature in a hood, but the exhaust fan is exhausting a constant volume. This increase in volume of supply air cuts down on that amount of air coming from the kitchen and you could end up with an 80-20 or 85-15 ratio of outside supply to room air with resultant spill-over.

   Take this into account on systems involving high heat equipment.