

AMCA (Air Movement and Control Association, Inc.)—A nationally recognized association that establishes standards, tests and certifies the performance of air moving devices.

A-Weighted—A term which refers to the single number logarithmic summation of the 8 octave bands that have been adjusted to account for response of the human ear to sound pressure level.

BHP (Brake Horsepower)—Fan horsepower required.

Btu (British Thermal Unit)—The amount of energy or heat required to raise the temperature of one pound of water one degree Fahrenheit.

BtuH—One Btu per hour.

CFM (Cubic Feet Per Minute)—A measure of volume flow rate, or air moving capability, of an air

moving device. Volume of air moved per minute.

dB (Decibel)—A measure of the sound produced by an air moving device.

dB(A)—Sound level reading on the A-weighted scale of a sound meter. This A-weighting adjusts response of the meter to approximate that of the human ear.

Free Air Delivery—The conditions existing when there are no effective restrictions to air flow (no static pressure) at the inlet or outlet of an air moving device.

HP (Horsepower)—The power required to drive an air moving device. HP required varies with system conditions—See Basic Laws below.

LWA—A value representing the logarithmic summation of all 8 octave band values, adjusted to

represent the effect of the "A" weighted network. This single number rating provides a useful number for comparison.

Octave Bands—The range of sound frequency that can be heard is divided into 8 octave bands.

Plenum Chamber—An air compartment maintained under pressure to serve one or more distributing ducts.

RPM (Revolutions Per Minute)—Speed at which the shaft of an air moving device is rotating.

Sone—An internationally recognized unit of loudness. Sones signify, in a single number, the total sound output of the unit being tested. One sone is approximately equal to the sound of a modern refrigerator in a kitchen. A 3-sone fan, for example,

sounds twice as quiet to the human ear as a 6-sone fan.

Sound Power Level—The acoustic power radiating from a sound source, expressed in decibels.

SP (Static Pressure)—A measure of the resistance to movement of forced air through a system or installation, caused by ductwork, inlets, louvers, etc. Measured in inches of water gage (W.G.); the height, in inches, to which the pressure will lift a column of water. For a given system, static pressure varies as the square of the flow rate. Thus, if flow rate is doubled, system resistance or static pressure is increased four times.

Venturi—A ring or panel surrounding the blades on a propeller type fan, which improves fan performance.

Centrifugal Blowers

Centrifugal blowers are air moving devices in which the air flow is perpendicular to the shaft on which the wheel is mounted. The wheel is mounted in a scroll-type housing, which is necessary to develop rated pressures. The four classes of centrifugal blowers are determined by wheel blade position with respect to the direction of rotation. As SP is increased, HP and CFM decrease.

Forward Curve (FC)

The tips of the blades are inclined in the direction of rotation; the most common type of centrifugal blower. Normally used in residential heating and air conditioning systems and light-duty exhaust systems where maximum air delivery and low noise levels are required. Capable of pressures up to approximately 1½" SP.

Backward Incline (BI)

The tips of the blades are inclined away from the direction of rotation. Used in commercial/industrial, heavy-duty heating/cooling systems that require heavy-duty construction, non-overloading characteristics and stable air delivery. These blowers operate at higher efficiencies than forward curved blowers. Not as quiet as forward curve blowers because they operate at higher speeds. Can be used in systems up to 3" static pressure. Smaller diameter wheels are supplied with flat blades; larger diameter wheels are supplied with air foil blades to improve efficiency.

Radial Blade

Has straight blades that are, to a large extent, self-cleaning, making them suitable for various kinds of material handling and particle-and-grease-laden air. Wheels are of simple construction and have relatively narrow blades. They can withstand the high speeds required to operate at higher static pressures (up to 12") but usually are noisier than FC or BI blowers.

In-Line (Tubular Centrifugal Fan)

Air flow is developed as in a centrifugal blower, but after leaving the impeller the air is contained in a tubular housing and, by means of turning vanes, is discharged in an axial direction. Employs single-inlet centrifugal wheels, usually with backward inclined blades. The tubular centrifugal fan has performance characteristics similar to a centrifugal blower and the compact physical configuration of the tubeaxial fan. Can be vertically or horizontally mounted, thus providing a simpler installation by minimizing need for duct turns and transitions.



FORWARD CURVE



FORWARD CURVE



BACKWARD INCLINE



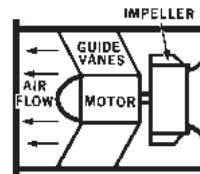
BACKWARD INCLINE



RADIAL



RADIAL

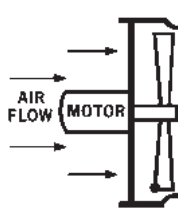


IN-LINE

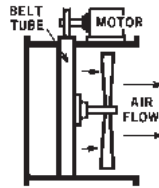


IN-LINE

Propeller Fans and Duct Fans



PROPELLER FAN (Axial)



DUCT FAN (Tubeaxial)



Propeller Fan (Axial Fan)—An air moving device in which the air flow is parallel or axial to the shaft on which the propeller is mounted. These fans have good efficiency near free air delivery and are used primarily in low static pressure, high volume applications. As SP is increased, HP increases and CFM decreases. Usually mounted in a venturi, ring, or other housing featuring simple construction and low cost.

Duct Fan (Tubeaxial)—An air moving device in which the air flow is parallel or axial to the shaft on which the propeller is mounted. The propeller is housed in a cylindrical tube or duct. This design enables duct fans to operate at higher static pressures than propeller fans. Commonly used in spray booth and other ducted exhaust systems. As SP is increased, HP increases and CFM decreases.

BASIC LAWS FOR AIR MOVING EQUIPMENT

The performance of all fans and blowers is governed by certain rules of physics known as Fan Laws. CFM, RPM, SP and HP are all related to each other in a known manner and when one changes, all others change. For example, when CFM is changed, RPM, SP and HP will also change. CFM is the variable most commonly changed in an air moving system, therefore the following example of fan law application is based on a change from an existing CFM to a new CFM.

1. To determine performance at a new CFM, first calculate the ratio of the new CFM to existing CFM (new CFM divided by existing CFM):

$$\text{Ratio} = \frac{\text{CFM new}}{\text{CFM existing}}$$

2. To determine new RPM, multiply ratio of step No. 1 times existing RPM:

$$\frac{\text{CFM new}}{\text{CFM existing}} \times \text{RPM existing}$$

3. To determine new SP, multiply ratio of step No. 1 times itself, times existing SP:

$$\text{SP new} = \left(\frac{\text{CFM new}}{\text{CFM existing}} \right)^2 \times \text{SP existing}$$

4. To determine new HP required, multiply ratio of step No. 1 times itself twice, and then times existing HP:

$$\text{HP new} = \left(\frac{\text{CFM new}}{\text{CFM existing}} \right)^3 \times \text{HP existing}$$

Sample Calculations

Existing conditions are 5000 CFM, 1000 RPM, 0.5" SP, 0.5 HP motor.

New CFM desired is 6000.

$$\text{Ratio} = \frac{6000}{5000} = 1.2$$

2. Calculate new RPM: $\frac{6000}{5000} = 1.2$, therefore new RPM = 1000 x 1.2 = 1200 RPM.

3. Calculate new SP: $\left(\frac{6000}{5000} \right)^2 = (1.2)^2 = 1.44$, therefore new SP = 0.5 x 1.44 = 0.72" SP.

4. Calculate new HP: $\left(\frac{6000}{5000} \right)^3 = (1.2)^3 = 1.73$, therefore new HP = 0.5 x 1.73 = 0.86 HP.

New conditions: 6000 CFM (up 20%), 1200 RPM (up 20%), 0.72" SP (up 44%), 0.86 HP (up 73%).

AIR CHANGES RECOMMENDED FOR VARIOUS AREAS

To determine the required fan capacity, calculate the volume of the area to be ventilated in cubic feet and divide by the minutes per change. Result will be cubic feet per minute, corresponding to fan ratings. One or more fans may be used to obtain desired cubic feet per minute.

| Ventilated Area | Minutes Per Change | Ventilated Area | Minutes Per Change | Ventilated Area | Minutes Per Change | Ventilated Area | Minutes Per Change |
|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|-------------------|--------------------|
| Assembly Halls | 3-10 | Factories | 4-10 | Offices | 5-12 | Shops | 5-10 |
| Bakeries | 1-3 | Foundries | 2-8 | Packing Houses | 3-5 | Stores | 5-10 |
| Boiler Rooms | 1-3 | Garages | 5-10 | Plating Rooms | 1-5 | Theaters | 3-8 |
| Cafeterias | 3-5 | Kitchens | 1-5 | Printing Shops | 5-10 | Toilets | 2-5 |
| Churches | 2-4 | Laundries | 1-3 | Restaurants | 3-10 | Transformer Rooms | 1-5 |
| Clubs | 5-7 | Libraries | 2-4 | Rest Rooms | 5-10 | Warehouses | 5-10 |
| Dormitories | 5-8 | Locker Rooms | 4-15 | Sales Rooms | 2-10 | | |
| Engine Rooms | 2-5 | Mills | 5-8 | Schools | 5-10 | | |



Typical Air Moving Devices



Unit Heater—Heater primarily designed for industrial and commercial applications; designed as one unitized assembly and usually suspended.

Universal Orifice—Orifice designed for use with both LPG and Natural Gas.

Upflow—Type of furnace with a blower in the bottom, which draws in cool air, moves it upward through the heat exchanger and then out the top to heated air ducts.

Vacuum—Pressure lower than atmospheric pressure.

V-Belt—Type of belt commonly used in refrigeration work. It has a

contact surface with the pulley in the shape of the letter V.

Valve, Expansion—Type of refrigerant control that maintains constant pressure in the low side of refrigerating mechanism. Valve is caused to operate by pressure in low or suction side. Often referred to as an automatic expansion valve or AEV.

Vapor Barrier—Thin plastic or metal foil sheet used in air conditioned structures to prevent water vapor from penetrating insulating material.

Vent Damper—Device that closes off a heater's flue during off cycles to prevent loss of heat energy.

Ventilation—The process of supplying or removing air to or from a room or space either by natural or mechanical means.

Venturi—A section of pipe or burner body that narrows down and then flares out again to increase gas velocity and create negative pressure.

Water-Cooler Condenser—Condensing unit cooled through use of water flow.

Wet Bulb Depression—The difference between dry bulb and wet bulb temperature.

Wet Bulb Temperature—The temperature of the air in a space or outdoors as measured by a

thermometer whose bulb is covered with a wet tubular wick or cloth.

Yellow Tipping—Yellow flicks in the tip of an otherwise blue flame; a symptom of the need for additional primary air.

Zeotropes—Show some amount of temperature glide when evaporating or condensing. Some may act like azeotropes (glide is not noticeable in normal operation, less than 3°F). Zeotropes with glides greater than 3°F will have one end of the evaporator warmer than the other. This may impact system performance.

Zone—Term used to describe any one loop in a multi-loop hydronic or air heating system.

Determining Heat Loss For Dayton Unit Heaters

This short method will estimate heat requirements in a building based on cu. ft. volume of building, and design. This is for preliminary estimates, NOT final sizing or BTUH loss computation of any heating equipment. Finite figures can only be determined through use of an ASHRAE heat loss study. Failure to use long form method or computer heat loss program may result in improperly sized heating equipment.

| Type Of Structure: | Frame / Masonry | | | RB Insulated Steel Wall | | | |
|--|-----------------|-----|-----|-------------------------|-----|-----|-----|
| | Indoor Temp (F) | | | | | | |
| | 60° | 65° | 70° | 60° | 65° | 70° | |
| | BTU/Cubic Foot | | | BTU/Cubic Foot | | | |
| Single Story 4 Walls Exposed | 3.4 | 3.7 | 4.0 | 2.2 | 2.4 | 2.6 | |
| Single Story One Heated Wall | 2.9 | 3.1 | 3.4 | 1.9 | 2.0 | 2.2 | |
| Single Floor One Heated Wall Heated Space Above | 1.9 | 2.0 | 2.2 | 1.3 | 1.4 | 1.5 | |
| Single Floor Two Heated Walls Heated Space Above | 1.4 | 1.5 | 1.6 | 0.9 | 1.0 | 1.1 | |
| Single Floor Two Heated Walls | 2.4 | 2.6 | 2.8 | 1.6 | 1.7 | 1.8 | |
| Multi Story | 2 Story | 2.9 | 3.1 | 3.4 | 1.9 | 2.1 | 2.2 |
| | 3 Story | 2.8 | 3.0 | 3.2 | 1.8 | 2.0 | 2.1 |
| | 4 Story | 2.7 | 2.9 | 3.1 | — | — | — |
| | 5 Story | 2.6 | 2.8 | 3.0 | — | — | — |

Values in chart at left are expressed in BTU for each cubic foot of building volume. Once volume in cubic feet is determined, multiply cubic volume by one factor listed. Then, multiply that answer by the following correction factors:

| Correct For Outdoor Temperature | Design Multiplier | Correct For "R" Factor (Steel Wall) "R" Factor | (Steel Wall) Multiplier |
|---------------------------------|-------------------|--|-------------------------|
| +50 | .23 | 8 | 1.00 |
| +40 | .36 | 10 | .97 |
| +30 | .53 | 12 | .95 |
| +20 | .69 | 14 | .93 |
| +10 | .84 | 16 | .92 |
| + 0 | 1.00 | 19 | .91 |
| -10 | 1.15 | | |
| -20 | 1.20 | | |
| -30 | 1.46 | | |

| City | GEOGRAPHIC OUTDOOR DESIGN TEMP (°F) | | Outdoor Design °F |
|------------------|-------------------------------------|-----------------|-------------------|
| | Outdoor Design °F | City | |
| Chicago, IL | -10 | Los Angeles, CA | +35 |
| Dallas, TX | +10 | Minneapolis, MN | -20 |
| Denver, CO | -10 | New York, NY | 0 |
| Jacksonville, FL | +30 | Seattle, WA | -10 |

Considerations Used For Above Values:

- 1—0°F Outdoor Design (See Corrections)
- 2—Slab Construction—If basement is involved multiply final BTUH by 1.7
- 3—Flat Roof
- 4—Window Area is 5% of Wall Area
- 5—Air Change is .5 Per Hour.

Temperature Control Terminology

Control Point—Temperature to be maintained for a system.

Differential—Temperature difference between the temperature at which the controller turns heat off and the temperature at which the heat is turned back on (expressed in degrees). Refers to On/Off controllers.

Hysteresis (dead band)—Temperature band between the On and Off of an output in the On/Off control action. No heating or cooling takes place. Band occurs between the times when the heat is turned off upon rising

temperature and turned on upon falling temperature.

On/Off Control Action—A control action with two controlled states.

Proportional Band—Range of temperature in which a manipulated variable is proportionate to any deviation from the set point.

Proportional Control Action (P)—A control action in which a manipulated variable is proportionate to any deviation from the set point.

Proportioning Control plus Derivative Function (PD)—A time-proportioning controller that has a

derivative function. The derivative function monitors the rate at which a system's temperature is either increasing or decreasing and adjusts the cycle time of the controller to minimize overshoot or undershoot.

Proportioning Control with Integral and Derivative Functions (PID)—A time-proportioning controller that has integral and derivative functions. The integral function automatically raises the stabilized system temperature to match the set point temperature to eliminate the difference caused by the time-proportioning function.

The derivative function monitors the rate of rise or fall of the system temperature and automatically adjusts the cycle time of the controller to minimize overshoot or undershoot.

Range—The area between low and high limits within which a quantity is measured.

Rate Action (D)—The controller senses the rate of change of temperature and provides an immediate change of output to minimize the eventual deviation.

Set Point—The value set on the temperature controller to control a system.

Residential Heating Equipment Sizing Guide (Short Form)

This short method will estimate heat requirements for a typically constructed residential home. This is for preliminary estimates. Due to the difference in construction and climate, it is recommended that a qualified heating professional perform a heat load study at the job site.

Steps for Calculations

Because of these variables, W. W. GRAINGER, INC. cannot assume the responsibility for personal injury and/or property damage to customers or other persons using this "Heat Equipment Sizing Guide".

| Calculations | Step-Totals | TOTAL |
|--|-------------|-------|
| <p>1. Windows: Total square footage of all windows (including glass doors) multiply by 39 = Btu heat loss</p> <p style="padding-left: 40px;">Total square footage of windows ____ x 39 = Btus required.</p> | | |
| <p>2. Doors: Square footage of all doors multiplied by 47 = Btu heat loss.</p> <p style="padding-left: 40px;">Total square footage of door ____ x 47 = Btus required.</p> | | |
| <p>3. Outside Walls: Total of all walls (Wall length x Wall height, in feet), minus total door and window square footage from steps #2 and #3 above = Total wall area. Total wall area x multiplier (from one of the wall descriptions described below) equals Btus required.</p> <p>WALL DESCRIPTIONS</p> <p>Above Ground Construction:</p> <p>A) Wood with siding - The heat loss multiplier is 6.</p> <p style="padding-left: 40px;">Wall area minus door ____ and window ____ area = Total wall area</p> <p style="padding-left: 80px;">Total wall area ____ x 6 = Btus required.</p> <p>B) Brick - The heat loss multiplier is 5.7.</p> <p style="padding-left: 40px;">Wall area minus (door ____ and window ____ area) = Total wall area</p> <p style="padding-left: 80px;">Total wall area ____ x 5.7 = Btus required.</p> <p>Below Ground Construction (Basement for example)</p> <p>C) Without insulation - The heat loss multiplier is 8.</p> <p style="padding-left: 40px;">Total wall area ____ x 8 = Btus required.</p> <p>D) With insulation - The heat loss multiplier is 4.</p> <p style="padding-left: 40px;">Total wall area ____ x 4 = Btus required.</p> <p style="padding-left: 40px;">Total heat loss through the walls ____ + ____ + ____ + ____ = (a+b+c+d) Total Btus required.</p> | | |
| <p>4. Floors: Total square feet (length x width) times one of the heat loss multipliers described below. Note: in 2 story construction use only the main floor for size and description.</p> <p>FLOOR DESCRIPTIONS</p> <p>A) Over crawlspace without insulation the multiplier is 8.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 8 = Btus required.</p> <p>B) Over crawlspace with insulation the multiplier is 3.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 3 = Btus required.</p> <p>C) Over garage without insulation the multiplier is 15.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 15 = Btus required.</p> <p>D) Over garage with insulation the multiplier is 5.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 5 = Btus required.</p> <p>E) Over basement the multiplier is 2.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 2 = Btus required.</p> <p>F) On concrete slab the multiplier is 29.</p> <p style="padding-left: 40px;">Total square feet of floor area ____ x 29 = Btus required.</p> <p>Total heat loss through the floor ____ + ____ + ____ + ____ = (a+b+c+d+e+f) Total Btus required.</p> | | |

