Technical Terms

CFM : Cubic Feet per Minute
This refers to the amount of air a fan is able to move.

Pressure
“Inches of water” is a common method of measuring the pressure a fan will generate.

RPM : Revolutions Per Minute
This refers to how fast the fan or motor is spinning. This has a direct connection to the air pressure and volume of air it can move.
**Density**
The flow, pressure or head, needs to be specified at a given density which is affected by temperature and altitude.

**Blower**
Centrifugal fans are often referred to as blowers.

**Wheel**
In centrifugal fans the impellers are frequently referred to as wheels.
Fan Selection Guide
Section 2: Types of Fans
Three main types of fans:

- Axial Fans
  - Low Pressure / High Volume
- Centrifugal Fans
  - High Pressure / Low Volume
- Mixed Flow Fans
  - Medium Pressure / Volume
  - High Efficiency / Low Noise
Axial fans are efficient high volume low pressure machines. These fans are good for general purposes: avionics/electric or personnel cooling; AC and ECS systems, especially if a fan is needed to move air through a heat exchanger.

These fans are also ideal for scavenging as the parts that come in contact with the air/sand mixture are more easily hardened than the complex shapes of other types of fans.
Axial fans come in two types, Vane-axial and Tube-Axial. Vane-axial fans differ from Tube-Axial’s as they have stationary vanes, sometimes called straightening vanes as they “straighten” the air outlet by counteracting the rotational angle from the turning impeller blades. These vanes allow a higher pressure capability and add efficiency.
Centrifugal Fans, also called Blowers are used for high pressure, lower flow applications such as NBC and other types of filtration. They are also used for low pressure lower flow general purpose applications as they can be made inexpensively by simple plastic and aluminum parts.
Centrifugal Fans are also used for AC systems where there is very long ducting that adds up to a lot of pressure drop.
Centrifugal Fans

Because the moving parts are covered by the scroll or housing, centrifugal blowers tend to be quieter than other types.
Mixed Flow Fans are called mixed as they are a sort of combination axial and centrifugal fan. They are basically Vane-axial fans, but the impeller is shaped like a bevel gear, where the fan blades are at an angle. This means the air is moved by a combination of aero-dynamic/mechanical pushing of air, and the centrifugal action of spinning the air against the housing.

In a blower, the housing is called a scroll, and in the mixed flow, the housing is called a shroud.
Mixed flows are usually made for NBC, or other critical applications for a specific design point where high efficiency and lower noise is required as these tend to be more expensive given their complex design. Mixed-flow fans tend to be quieter than other types because of their efficiency and that their moving parts are partially blocked by the shroud.
Non-Airfoil propellers have blades that are the same thickness the entire length. They are designed to move the air through shear mechanics. This is good for fans that must run at variable speeds.

Airfoil blades have a shape to them much like an airplane wing. These blades are more efficient than non-airfoil; however, they are generally designed for only one point on the performance curve. This makes airfoil fans less versatile.
A basic fan is a propeller / impeller mounted on a motor shaft.

Add a housing around the propeller and motor and you have a “tube axial”.

Add “guide vanes” also called “straightening vanes” and you have a vane axial fan.
DAE Systems

Fan Selection Guide
Section 3: Types of Drives
Types of Drives:

- A.C. Motor
  - Single Speed
  - Multi-Speed
- D.C. Motor
  - Brush-Type
  - Brushless
• Direct Drive
  • This is simply an impeller mounted on a drive shaft with a set of bearings within a housing. The drive shaft can be coupled to any rotating driver.
**Hydraulic**

- Once used for variable speed, these are not recommended. They are expensive, have long lead times, and leak.
- Variable speed is best achieved using brushless DC or inverter driven AC motored fans.
DAE Systems

Fan Selection Guide
Section 4: Basic Calculations
FAN LAWS

\[
\frac{\text{RPM}_1}{\text{RPM}_2} = \frac{\text{CFM}_1}{\text{CFM}_2} = 10\% \text{ INCREASE IN RPM}
\]

\[
\left(\frac{\text{RPM}_1}{\text{RPM}_2}\right)^2 = \frac{P_1}{P_2} = 10\% \text{ INCREASE IN RPM}
\]

\[
\left(\frac{\text{RPM}_1}{\text{RPM}_2}\right)^3 = \frac{W_1}{W_2} = 10\% \text{ INCREASE IN RPM}
\]

CFM DOES NOT CHANGE WITH DENSITY.
PRESSURE AND POWER VARY DIRECTLY WITH DENSITY.
BASIC CALCULATIONS

CFM vs MASS FLOW

\[ m(\text{lbs/min}) = \text{air density (lbs/cu ft)} \times \text{cfm} \]

\[ \text{cfm} = \frac{\text{mass flow (lbs/min)}}{\text{air density (lbs/cu ft)}} \]

Example: \[ \frac{50 \text{ lbs/min}}{0.0765 \text{ lbs/cu ft}} = 653.6 \text{ cfm} \]

PRESSURE

1 psi - 27.7 inches of water - 2.036 inches of mercury (in Hg)

Velocity Pressure \( (P_v) \):

\[ P_v = \frac{\text{velocity squared (v}^2\text{)}}{4372 \times 0.0765 \text{ air density}} \]
BASIC CALCULATIONS

AIR HORSEPOWER

\[ AHP = \frac{\text{CFM} \times \text{Total Pressure}}{6356} \]

TOTAL HORSEPOWER

\[ BHP = \frac{AHP}{\text{Fan eff.}} \quad \text{Input HP} = \frac{BHP}{\text{Motor eff.}} \]
BASIC CALCULATIONS

AIR DENSITY CALCULATION

\[ \rho \text{ (lb/ft}^3\text{)} = 0.07647 \times \left( \frac{P}{P_0} \right) \times \left( \frac{T}{T_0} \right) \]

\[ \rho \text{ (kg/m}^3\text{)} = 16.0169 \times \rho \text{ (lb/ft}^3\text{)} \]

\[ \rho \text{ (lb/ft}^3\text{)} = 1.326 \times \rho_b \text{ (in HG)} / (459.7 + T_F) \]
Fan Selection Guide
Section 5: Miscellaneous
Miscellaneous Topics:

- Fan Testing
- Noise Measurement & Control
- Environmental Considerations
- Inrush Current
Fan testing is done per the set-up on the next slide. While the instrumentation has been modernized, the basic ASRHA test stand equipment has been in use for decades, allowing consistent test results.
PROVISIONS FOR MEASUREMENT OF:

- Barometric Pressure
- Wet and Dry Bulb Temperature

TEST CONFIGURATION NO. 1 FOR VANEAXIAL FANS

(D = Inside Diameter)
Noise Measurement

Noise data is available at no cost as most fans have the dba on the catalog page. This is the noise measured in the concrete floored test lab at 5 feet at 45 degrees from the fan outlet while in a test duct. This allows comparison to different fans at no cost.

DAE can quote to have our product tested in an independent laboratory in an anechoic chamber according to a defined procedure.
Environmental Considerations

It is important to know the ambient temperature and characteristics such as shock, vibration, salt water & high altitude, which requires special design and material.

In rush current is about 2-3 times full load current and drops to full load typically in about 5-6 seconds.